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VOL. IX. NEW YORK, FEBRUARY, 1905. No. 12.

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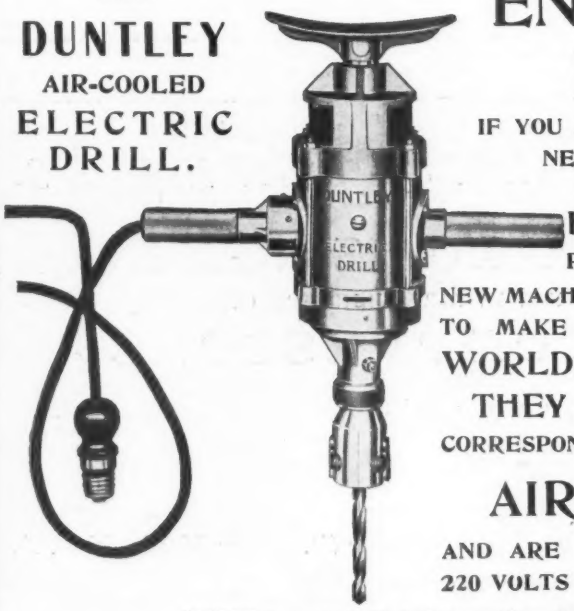

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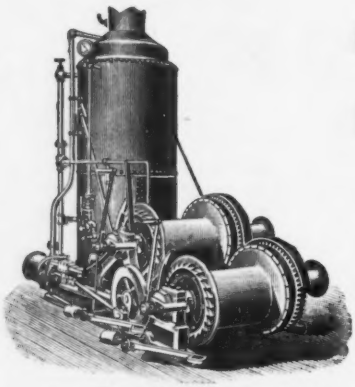

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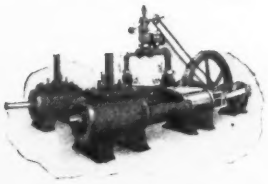

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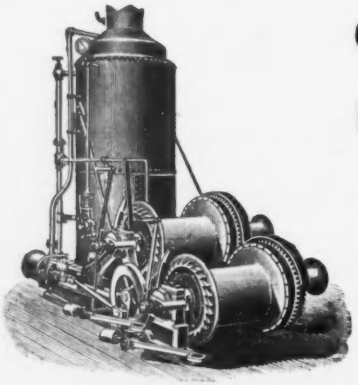

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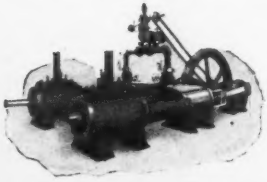

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26 Cortlandt Street,
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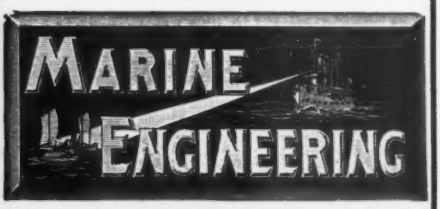
My Dear Mr. Saunders:—I must congratulate you on the very excellent work "Compressed Air Information" and I hope the engineering public will appreciate it to the extent that it will remunerate you for the care and attention you must have devoted to the book in order to present the information contained in so useful a manner.

I find it contains all necessary information upon Compressed Air subjects contemporary with its publication. I use it for reference, and on more than one occasion it has rendered me substantial benefits worth many times its price. I wish you all success.

Very truly yours,
E. A. RIX.



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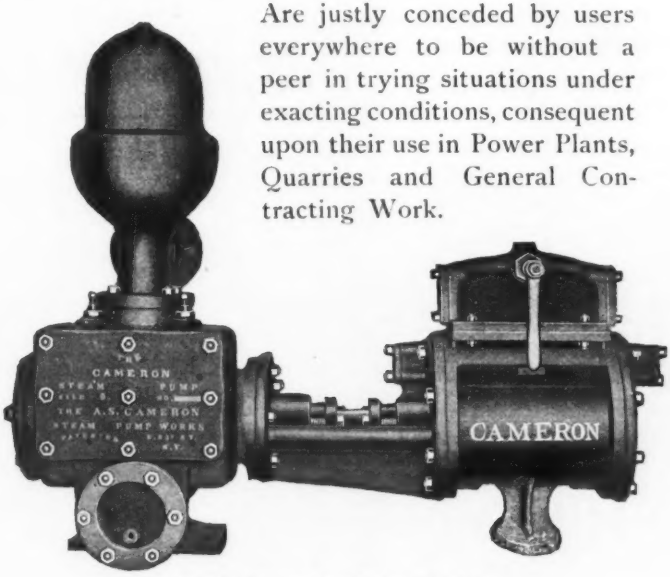

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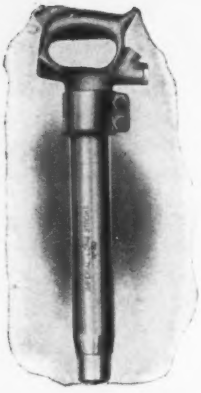

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A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

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Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

All communications should be addressed to COMPRESSED AIR, 26 Cortlandt St., New York.

London Office, 114 Queen Victoria Street.

Those who fail to receive papers promptly will please notify us at once.

Entered as Second-Class Matter at the New York, N. Y., Post Office.

VOL. IX. FEBRUARY, 1905. NO. 12

Compressed Air on the Modern Railway.

In two important ways compressed air has made itself invaluable in the operation of the modern steam railway. It is best known, perhaps, through the success of the air brake. With cars of greater weight and locomotives of increased speed, it was recognized that some form of power must be utilized to operate the brakes. Compressed air has best filled the requirements. No matter how small the railroad, the air brake is a necessary part of its equipment.

With the experiments looking toward the substitution of electricity for steam power, there is little likelihood of electricity supplanting the pneumatic brake. The electric car of the present day has followed the example of the steam locomotive, compressing air for operating its brakes, either with an individual compressor or by the storage system.

Later in its development than the air brake is the electro-pneumatic switch and signal systems. The advantages of compressed air in connection with electricity for the operation of block signals were appreciated some years ago, and many of the principal railroads of to-day have such signals in successful operation. Strictly electric systems possess certain advantages, although they lack the sureness of operation which is guaranteed by the use of air.

In operating the switches, however, electricity has not been able to do the work. The latter power is used, as in the signals, to operate the valves of the pneumatic system, but it requires the compressed air to force the points of the switches to their proper places. A cylinder between the rails with a piston, connected to the switch points on either side, is a simple means of opening and closing the switch.

Where the switches are but seldom used the automatic method is not required. The freight yards and the network of tracks at the entrance to any terminal station are important points in the operation of a railroad even of moderate size and require some method of control that will enable the prompt and certain operation of the switches from a central point. The old system of automatic switch control, which depended largely on the strong arm of the operator in the tower, was very limited in extent. The new system has such a variety of advantages that its superiority is not questioned.

This season of the year serves to bring prominently forward one important defect, if such it may be called, of the pneumatic system of switches. When the snow appears, there is trouble for the switches, as, unless the points are kept perfectly free from snow, the air has difficulty in closing them. The pressure used is amply sufficient to throw them together under ordinary circumstances, but not with snow packed between them. With the old hand

automatic switches the snow was equally troublesome. It leaves, however, one thing to be desired in the successful operation of the pneumatic switch.

That old enemy, moisture, also offers an opportunity for trouble in the air lines of the pneumatic switches and signals. Unless special care is used in the winter time to keep the pipes free from water, freezing is going to result and the consequences are likely to be serious. With care in placing a receiver or after-cooler in such a place as to condense any moisture that may be contained in the air as it comes from the compressor, there need be no trouble on this score. Most lines are laid with drip cocks at the low points in the line so that any moisture which does collect may be properly drawn off.

Where the air lines are of any length the expansion and contraction of the pipe in the varying temperatures becomes a subject for consideration. Expansion joints are used which will allow for all necessary adjustment without loss of pressure.

One of the most elaborate terminal stations of the country is located at St. Louis, Mo., the property of the Terminal Association of that city. During the Exposition that closed last November at that city, this station was called upon to receive and send out a record-breaking number of trains. The switch and signal system which answered these requirements was the largest in the country. As the installation is but a recent one, the description which appears in this issue is of special interest to those who keep in touch with the progress compressed air and its applications are making.

Another Advertising Contest.

The second advertising competition which COMPRESSED AIR is now conducting for the Ingersoll-Sergeant Drill Company has started. A number of suggestions have already been received. Many more will follow. For the benefit of those who did not read the conditions as given in the January number of this publication, they are summed up briefly as follows:

At least four prizes will be awarded for the best suggestions for advertisements or mailing cards. They will be as follows:

First prize	$25 00
Second prize	15 00
Third prize	10 00
Fourth prize	5 00

Each advertisement should be prepared for one of the following trade papers, designed to fill the same space as the company's regular advertisement in that paper: *American Machinist, Colliery Guardian,* COMPRESSED AIR, *Engineering Magazine, Engineering News, Engineering and Mining Journal, Granite, Mining and Scientific Press, Mines and Minerals, Railroad Gazette, Railway Age* and *Rock Products.* Strength and effective display will receive first consideration. The right is reserved to copyright and use any of the suggestions submitted.

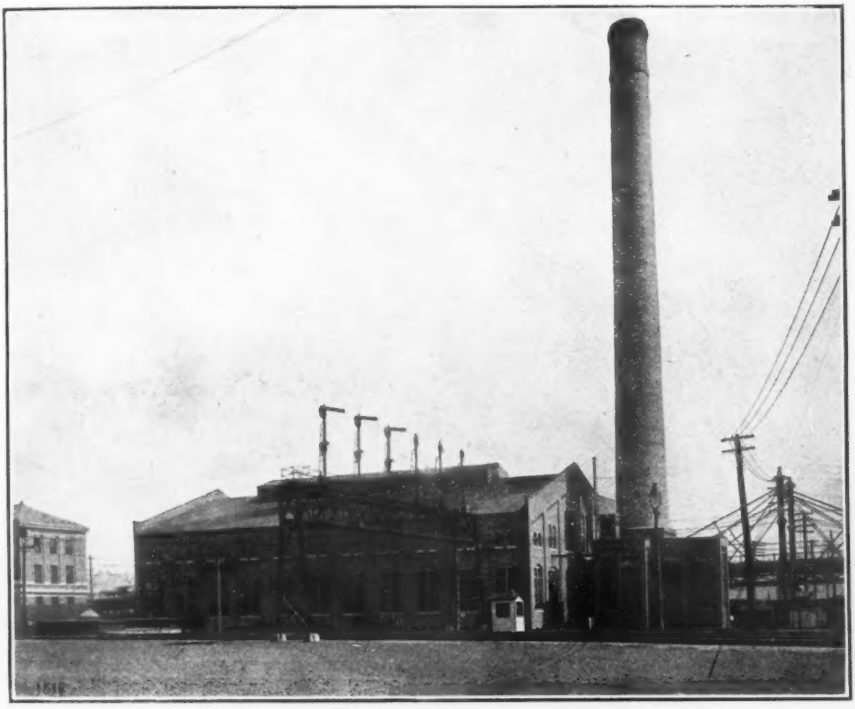
Particular attention is called to the fact that the contest will be open only to any firm or individual using Ingersoll-Sergeant machinery, any stockholder or employee of a company using Ingersoll-Sergeant machinery, or anyone in the employ of that company.

All suggestions should be sent to COMPRESSED AIR, 26 Cortlandt street. The contest will close April 1, and the awards will be announced as soon as possible after that time.

The Central Compressed Air Power Plant of the St. Louis Terminal Station.

The Union Terminal Station at St. Louis, Mo., is one of the largest railway stations in the world, and the vast passenger traffic which it has so successfully handled in connection with the Louisiana Purchase Exposition has

brought it conspicuously before the eyes of the world. The immense train sheds, the multitudinous tracks and the handsome station building have made a lasting impression upon the throng of visitors to the World's Fair. The Terminal system as a whole has been repeatedly described in the technical press, but in these descriptions one very important feature of the equipment has been necessarily treated in only a general way. The

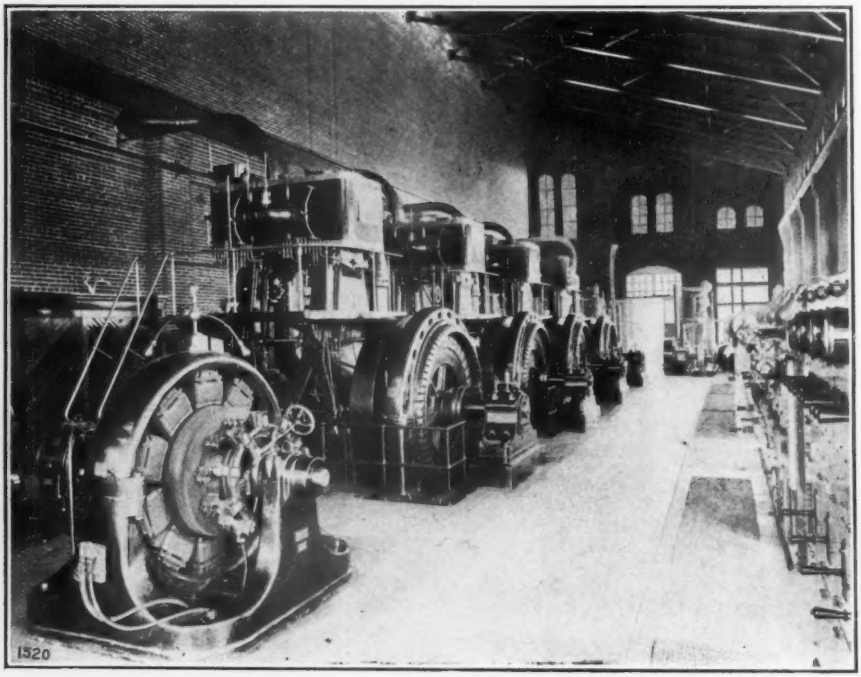


POWER HOUSE OF THE ST. LOUIS RAILWAY TERMINAL, ST. LOUIS, MO.

compressed air equipment is the feature referred to, and it is the purpose of this article to call attention to the important and novel features which make this one of the most complete installations of its kind in the world.

The air compressing plant proper is located in the main power house of the Terminal Station on Eighteenth street, south of the train sheds. It consists of two duplex steam-driven, two-stage air compressors, built by the Ingersoll-Sergeant Drill Company of New York, and of the type known by the makers as Class "GC." These compressors take steam from the central boiler plant at 150 pounds pressure and run non-condensing. The duplex steam cylinders are each 18 inches in diameter; low pressure air cylinder is 32¼ inches, high pressure air cylinder 20¼ inches in diameter; the common stroke is 24 inches. Both high and low pressure air cylinders are equipped with the piston inlet valve, a device distinctive of Ingersoll-Sergeant compressors. The power of each compressor unit is about 350 horse power, and at the rated normal speed of 100 revolutions per minute the free air displacement of each machine is 2,180 cubic feet per minute, delivered at a pressure of 85 pounds. The air intake conduit leads cold air from the outside

to the machines, and this, with the large vertical receiver inter-cooler between stages and the jacketed air cylinders, assures the highest economy of compression. The air discharge pipe from the high pressure cylinder is 6 inches in diameter and leads to the receiver outside the engine room. Each unit has its own receiver, of vertical type, 36 inches in diameter and 16 feet long. These are mounted side by side in the cooling house or tower to the south of the main engine tower. This second header is a little more than twice as long as the first, and from the other half of it an equal number of ¾-inch pipes branch downward to a third header of the same size as, and in line with, the first header. In effect this arrangement is that of a large number of U tubes, through which the air circulates with the maximum air-cooling effect. From the third header the air enters another secondary receiver of the same size as the first secondary



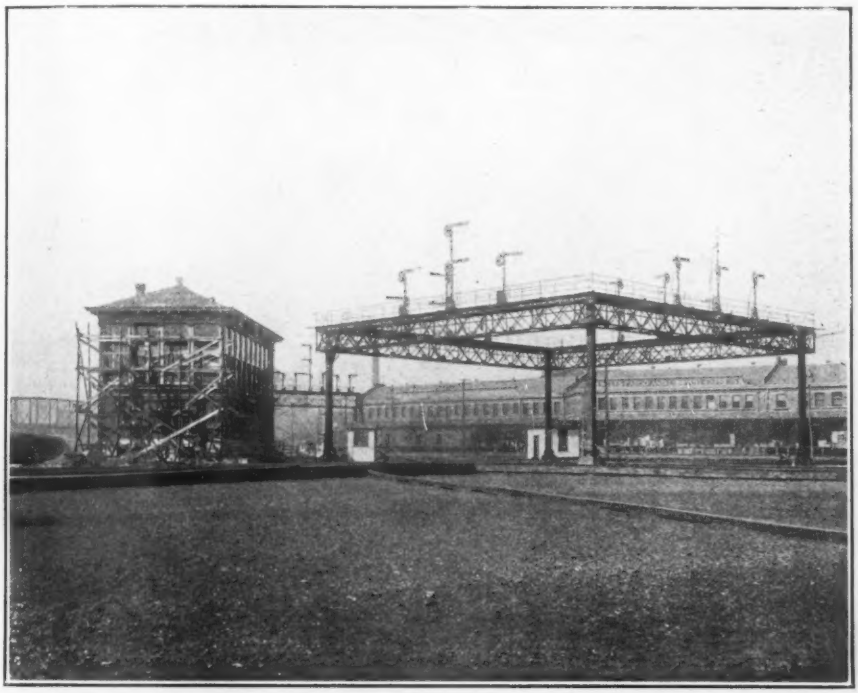
ENGINE ROOM IN THE POWER HOUSE OF THE ST. LOUIS RAILWAY TERMINAL.

room. In this same building is also the air cooling and drying system, of novel construction and of most effective design.

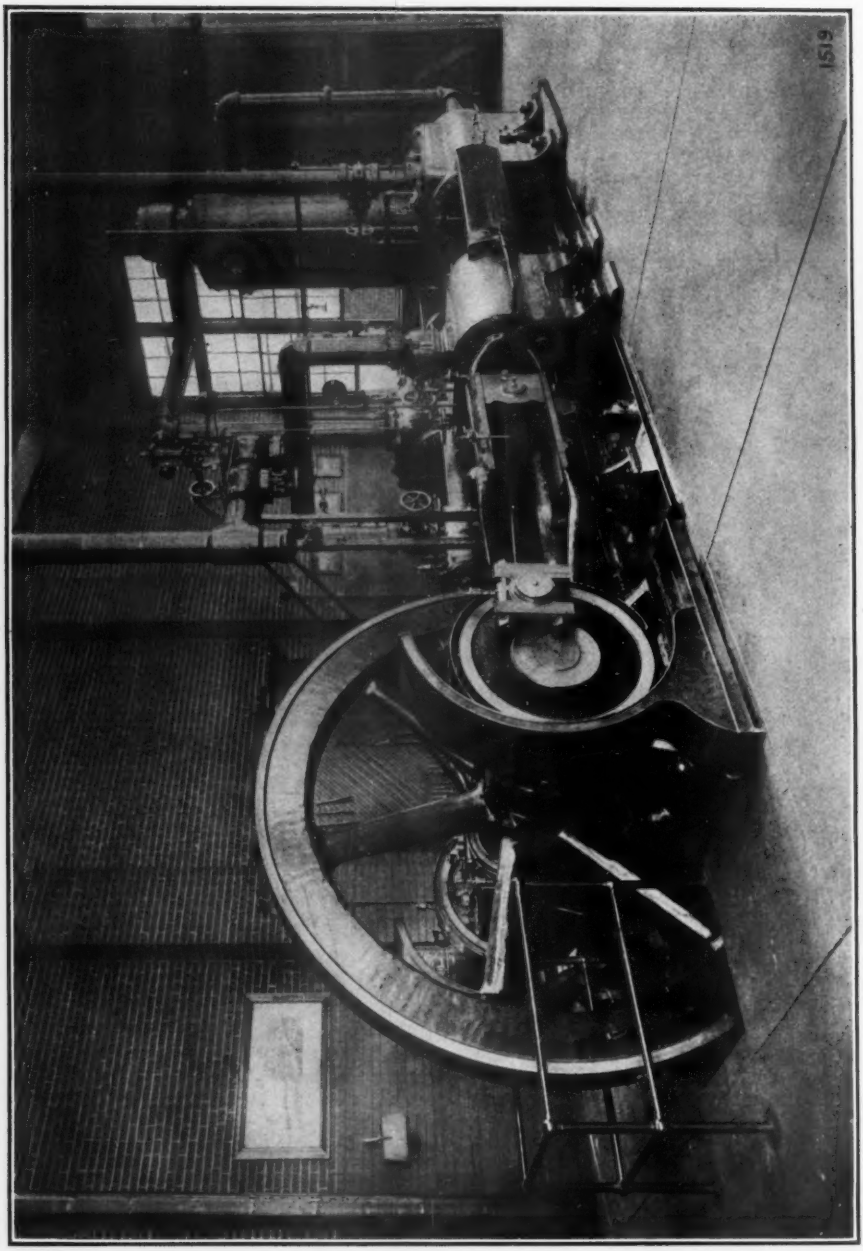
A pipe from each of the primary receivers leads to a secondary receiver 30 inches in diameter by 3 feet long, from which it discharges into a lower 4-inch horizontal header. Branching from this header is a great number of ¾-inch pipes, leading vertically to another 4-inch header near the roof of the cooling and emerges thence to the lines. The general scheme is suggested in the illustration. Drip cocks are inserted in the lower headers and in the secondary and primary receivers. It is found that all moisture is condensed in this system and removed through the drain cocks. Only in the most severe weather has it been found necessary to inject alcohol into the air pipes of the switch and signal system to

prevent freezing. While the cooling system is in duplicate, that is, made up of two primary and secondary receivers and cooling devices as described, yet the piping arrangements are such that the two can be connected in parallel or the discharge from both compressors delivered through either one of the two branches. The large openings in the walls of the cooling tower are closed by adjustable shutters, by which the circulation of outside air through the room can be regulated to a nicety.

The uses of the air from this central system are many and varied. The general scheme of distribution is as follows: from the centre of distribution—the cooling tower—five main branch lines radiate; a 3-inch pipe main, about 5,000 feet in length, leads to the Grand avenue yards, where the air is applied in an interlocking switch and signal system. The power is also used in the Grand avenue shops in driving two 4 by 5 inch standard Westinghouse engine generators, furnishing current for the signal system at from 22 to 31 volts; several small engines for other purposes are also run from this line. Another 3-inch branch leads to the Atlantic street yards, a distance of about 3,000 feet, where the air is applied in cleaning cars, charging the brake reservoirs and in the operation of car jacks. A third branch of 3-inch pipe, 2,500 feet long, leads to the Poplar street yard, where the air is applied in another system of interlocking switches and signals. A fourth branch is a 4-inch pipe leading to the train sheds of the main Terminal, a distance of 1,800 feet. Here the air power is applied in charging the brake reservoirs, in lifting jacks and in cleaning cars, while a branch pipe leads to the main head-house or station building,

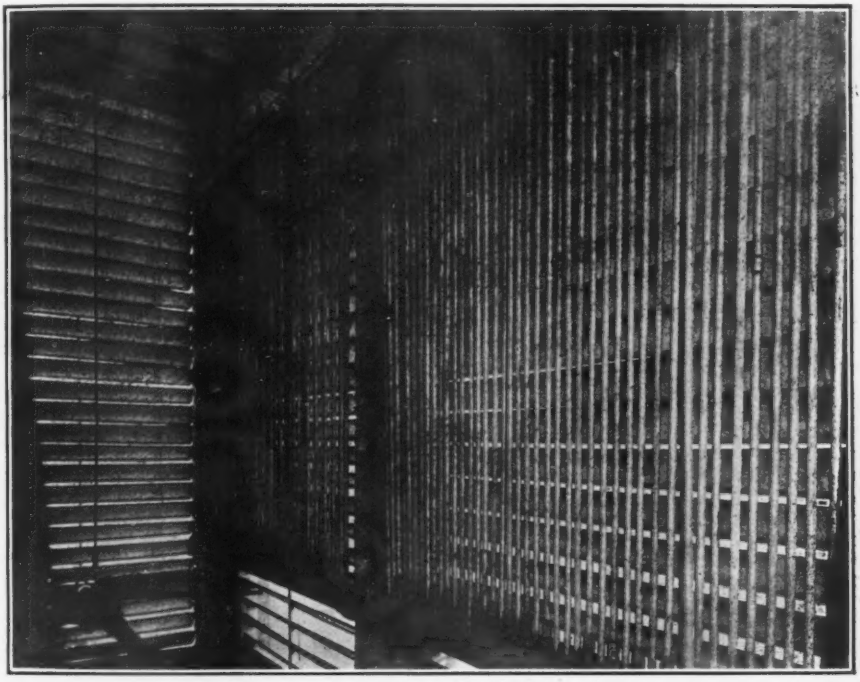


MAIN SIGNAL TOWER AND BRIDGE—HEAD-END YARDS, ST. LOUIS RAILWAY TERMINAL.



ONE OF THE TWO CLASS "GC" AIR COMPRESSORS IN THE ENGINE-ROOM OF THE ST. LOUIS RAILWAY TERMINAL.

where the air is used in the pneumatic dispatch tube system communicating between the telegraph office, baggage rooms, information bureau, express office and the other departments of the Terminal enterprise. In the offices of the station the air is applied in the letter presses, which are equipped with small pneumatic cylinders in place of the ordinary screws. The fifth branch of the air distribution system is a 3-inch line, supplying the



INTERIOR OF AIR COOLING TOWER, SHOWING COOLING PIPE SYSTEM.

main switch and signal system of the Terminal station and Head-end yards.

In the Fourteenth Street engine-house air from one branch of the system is used to blow the fires of the locomotives and to operate forges, hoists, pneumatic tools and the various other pneumatic appliances of the railway repair shop.

The pipe distribution systems for air, steam and water are carefully worked out along lines of greatest effectiveness and economy. These three lines of piping are laid side by side in boxes; they are easily accessible and open to inspection, yet are protected against the elements and accidental injury. The greatest care is exercised to avoid all leakage losses and the pipe system is maintained at the highest efficiency. In all the yards—Sixteenth Street, Twenty-first Street, Express, Head-end and Atlantic Street—and wherever the air power is likely to be found useful, ¾-inch hose connections are inserted at intervals in the pipe lines, by which air can be applied for any purpose desired. Among some of the other minor applications of air may be mentioned the Shone ejectors, three in number, which are installed in the Terminal subway, to discharge any seepage water which may collect. These appliances, having a capacity of 250 gallons per minute each, are placed in a sump about midway of the main subway and are automatic in action; that is, when

the cylinders fill with water the automatic valve opens to admit air to eject the water and closes when the cylinders are empty; the pumps are then ready for another charge. In the accumulator pit of the main hydraulic elevator system small duplex bilge pumps, air-driven and automatic, handle any water which may escape into the pit. Throughout the yards the air is used in blowing the yard signals, and in the main power house it is found extremely useful in cleaning the machinery.

But perhaps the most important application of the compressed air, and certainly the most conspicuous one, is seen in the remarkable system of interlocking switches and signals which control the movement of trains to and from the main Terminal Station. This controlling system was installed by the Union Switch and Signal Company and its details are of standard type. The importance of this scheme of train control will be realized when it is understood that the average number of trains handled during the day in the St. Louis Terminal Station is between 500 and 550, aggregating from 2,000 to 2,500 cars; it has been known to run as high as 750. This represents the passenger trains alone which leave and enter the station and does not include the freight traffic which passes over some of the tracks controlled by this central system. There are six entering track leads from the east and six from the west, converging into six tracks, which again branch into the thirty-two tracks under the train shed. The illustration shows the main switch and signal tower and the main signal bridge. In addition to the signals shown, there are two other bridges spanning the tracks under the main train sheds and two on branch leads. The total number of signals is 284; the total number of bridges is 20, and the total number of switches is 157. These figures refer to the main Terminal control alone. Beside these, there are probably as many more towers, switches and signals in the yards at Fourteenth street, Twenty-third Street and Grand Avenue.

The system of train control has been operating with wonderful success under the excessive service requirements of Exposition traffic. An example may show the strenuous demands which from time to time come upon the switch and signal system. On July 14th and 15th, for a period of twenty-four hours, beginning and ending at 4 P. M., 2,203 train and engine movements were recorded at the main signal tower. These were subdivided as follows: loaded passenger trains entering and leaving the station, 740; empty coach trains sent to the storage yards, 396; light engines, 792; switching movements, 188; freight movements, 87.

This is a sample of the service which the switch and signal system is called upon to perform—a service which it would be impossible to handle with any other than the electro-pneumatic system of control. The whole installation illustrates strikingly the part which compressed air has come to play in the traffic problems of modern transportation systems.

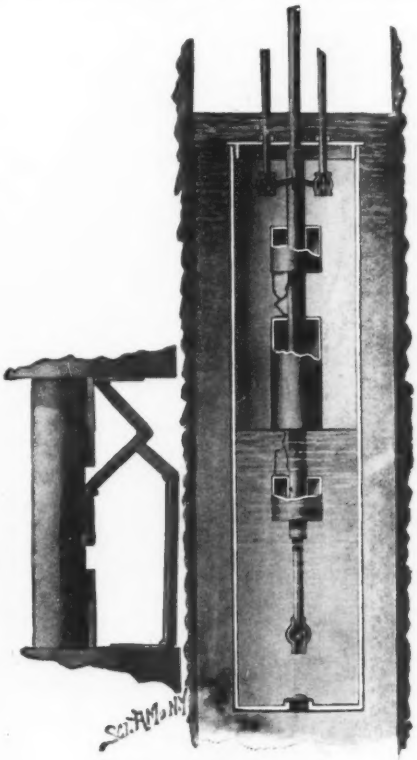
A Compressed Air Pump.

The application of compressed air to the raising of liquids has been tried with varying success. The following description outlines briefly a pump which I have designed:

An air-tight chamber is attached to the lower end of the well pipe and must extend below the surface of the water. The well pipe is fitted air-tight through the top of the chamber and extends nearly to the bottom. Two other pipes enter the chamber at the top, and have valves at their lower ends inside the chamber, which are opened and closed by the large float inside the chamber, which is attached to a sleeve working up and down on the well pipe, and to which the levers or arms controlling the valves are attached. One of these pipes admits the compressed air, which, being lighter than water, remains above the water and forces the water into the bottom of the well pipe through a valve which opens upward, but which will not permit the water to return. As soon as the water is emptied below the large float this float falls and closes the valve of the pipe admitting compressed air, thus shutting off the air pressure. At the same time this valve is closed the valve to the other air pipe is opened and permits the air to escape or rise. As the air escapes a valve in the bottom of the chamber is forced open by the pressure of the water in the well and

the chamber immediately fills with water. When the chamber fills sufficiently the float rises, opens the valve admitting compressed air (at the same time closing the valve which permitted the air to escape), and the air pressure again forces the water up through the well pipe until the chamber is emptied. And so it continues, filling and emptying the chamber.

The two small floats, one above and the other below the larger float, are for the purpose of locking the large float. When the chamber is filling and the water reaches the large float it cannot rise until the water has risen to the small upper float, which rises with a quick movement, causing the valves to set instantaneously. The small lower float is so arranged that it serves the same purpose when the water is going down.



A COMPRESSED AIR PUMP.

The large float would work alone, but it would fall slowly as the chamber was emptied, gradually shutting off the supply pipe and gradually opening the escape pipe, so that a great deal of air would escape before the chamber is emptied. The illustration shows how the float is attached to the well pipe.

The water pipe can be extended into the house and elsewhere, as desired, and is always ready when the faucet is turned. It is not necessary to store in a tank, because your water pressure is always equal to your air pressure. If desired, air can be stored or compressed in a tank and be ready for use whenever needed.

If a well furnishes a small supply of water this pump will take it out as fast as it runs in, because when emptied it will not work until the chamber fills again. But just as soon as sufficient water runs in to raise the float it starts to work, and no air is wasted or energy lost. A number of wells can be operated from the same air compressor by connecting the air pipe.

The pump illustrated is designed for a drilled well. Water, oil or any liquid can be raised with this pump. The compressor can be operated by hand for domestic use, and by windmill or other machinery, according to the amount desired.

E. HASTAIN, Inventor,
Muskogee, Indian Territory.

An Independent Valve Gear.

In designing machinery for the use of compressed air it is essential that it should be certain in its action, easily accessible for repairs, few in parts and long life to such parts.

Some of the greatest uses of air are for rock drills, coal cutters, stamp mills for ore, pattern rapping, mold ramming, bench molding, sand sifting and pneumatic drills. In rock drilling and coal cutting the correct principle is to get a hole into the solid material of the right size without any hitches, with the least hand work; in order to do this the drill must be under absolute control of the operator; it must be light, portable and easily erected and dismantled, of good materials and not complicated, being so simple that its successful operation is readily mastered by the operator. All parts should be protected from dust, grit, exposure or rough treatment.

Sometimes in drilling a seam is struck and the drill sticks, causing a spasmodic action of the valve gear, creating a kick, to the danger of the operator; whereas, with an INDEPENDENT VALVE GEAR this could not happen, as the valves run right along, admitting and exhausting the air.

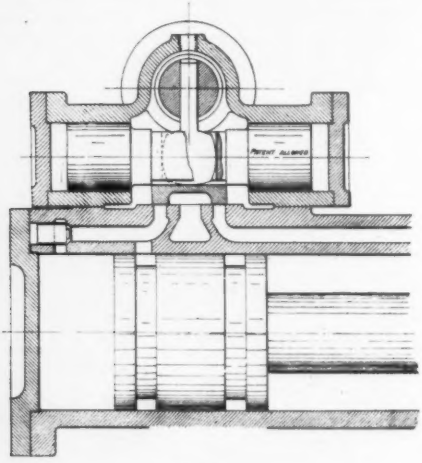


FIG. I.

Figures 1 and 2 show the independent valve gear as adapted to control the valve of a rock drill or coal cutter, operated independently of any moving part of the drills.

The gear comprises two piston-like valve members, each controlling an inlet and an outlet port, and means for connecting said members, whereby each gives the other the movement necessary to open or close the corresponding ports. The valve members operate in cylinders at *right angles* to each other, and the connection between them is such that the longitudinal movement of one member operates to rock or give an angular movement to the other member. The ports are so arranged that the angular or oscillating movement of each member reverses the latter.

In operation the air is admitted to one end of one cylinder and drives one of the members forward longitudinally; this movement, through the connection between members, rocks or oscillates the other member and thereby opens the inlet and outlet to the cylinder in which said latter member operates, so that said member is driven forward. This longitudinal movement of the second member rocks or oscillates the first member, thereby reversing the latter, whereby it is given a backward longitudinal movement. This movement in turn rocks the second member and reverses it, so that it is given a backward longitudinal movement.

In this construction it will be seen that each member acts reciprocally on the other and that the longitudinal movement

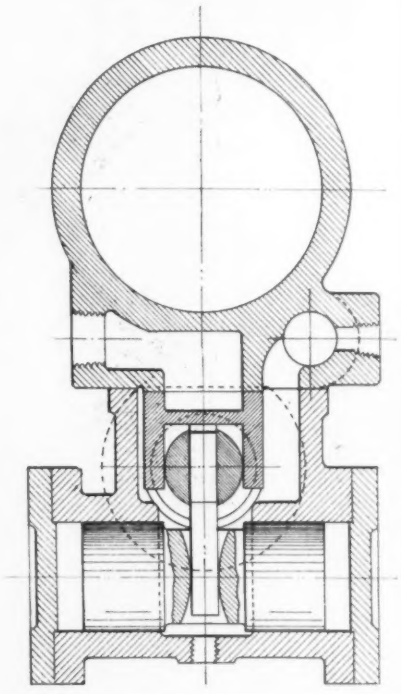


FIG. II.

of one operates to reverse the other. By connecting the main valve of the drill or other device to one of the members its longitudinal movement back and forth may be utilized to operate said valve. To secure the least possible wear and minimum breakage the metal can be so chosen that there will be practically an entire absence of repairs.

WM. F. TORREY,
No. 26 Greenville Street,
Roxbury, Mass.

The Compressed Air Power Plants for the Pennsylvania Railroad Tunnel.

Work is well under way on the tunnels under North and East Rivers by which the Pennsylvania Railroad will enter New York City. The driving of these tunnels is the greatest undertaking in the history of subaqueous tunneling and no effort has been spared to make the method of procedure the very latest and most up-to-date. As was naturally to be expected, compressed air is to bear the greater part of the burden of pushing these immense tubes under the rivers, and the compressor plants by which it is to be furnished will represent the latest developments of pneumatic practice. The contracts for the air power equipments were awarded to the Ingersoll-Sergeant Drill Company of New York, and that company is now installing the machinery which will make up the completed plants. The work is to be carried on in two distinct sections and under two separate contracts.

The larger of the two contracts was that for tunneling under the East River, and it was secured by S. Pearson & Son, Incorporated. The contract provides for the building of four parallel tubes between Long Island and Manhattan, each to be 33 feet in diameter. The work is to be pushed from both ends at the same time, and the power plant has been subdivided into two sections, one on either side of the river, identical in capacity and character. The plant on the New York side is located at Thirty-second street and First avenue, and on the Long Island side the main power station is to be found at the foot of Flushing street, Long Island City. At the shaft at East avenue, Long Island City, preliminary work is being carried on with the assistance of a temporary air plant, comprising two Ingersoll-Sergeant Class "A" Compressors, with a combined capacity of 1,200 cubic feet of free air per minute.

The main air-compressing plants on the East River tunnel will, together, include twelve Ingersoll-Sergeant cross-compound Corliss steam-driven compressors with duplex air ends, of the latest type. Of these, eight are to be low-pressure units, each with a capacity of 5,000 cubic feet of free air per minute compressed to 50 pounds from atmospheric intake. The air from these machines is to be used in the tunnels for keeping out the water and mud as the shields are driven forward. The low-pressure air is delivered to the tubes by four 10-inch mains on either side of the river. In addition to these low-pressure units there are to be two high-pressure compressors of the same general type, but designed to draw their intake either from atmospheric or from the discharge of the low-pressure machines. In the former case the capacity of each is 1,500 cubic feet of free air compressed to 100 pounds; in the second case it is from 2,000 to 6,600 cubic feet of free air per minute, delivered at pressures up to 150 pounds, depending on the intake pressure. This high-pressure air is distributed on the Long Island side through an 8-inch pipe line, and on the New York side by a 6-inch main; it is to be used for running rock drills, driving concrete mixing machines and possibly for pneumatic haulage. The remaining two units of the system are to be combination compressors, having steam cylinders of the same size as the machines above described, but coupled up in tandem to two pairs of duplex high and low pressure air cylinders, of diameters 15½ and 22½ inches respectively. Either set of compressing cylinders may be thrown into operation, and it is thus seen that these combination machines serve the purpose of duplicate or reserve units for either the high or low pressure compressors. The compressing plant as described is divided equally between the two stations on opposite sides of the river, and each portion is served by a battery of five 500 horse-power water-tube boilers, delivering steam at 150 pounds pressure. All these machines are equipped with the Ingersoll-Sergeant positive air-thrown air valves for both intake and discharge—the latest refinement of compressor design. The engineering details of each plant have been carefully worked out and a great flexibility is provided in piping and receiver connection, by which any compressor or combination of compressors can be made to furnish air to any tunnel. The work of installation of these plants is progressing rapidly. Boiler and engine foundations are complete and one

of the large Corliss compressors is already in place. The rest are to follow at the rate of one unit per week.

The contract for the North River tunnels is not so extensive as that for the East River, since the plans contemplate only two tubes of a diameter of 33 feet. The O'Rourke Engineering Construction Company, of New York, was awarded this contract, and its machinery also is now being installed by the Ingersoll-Sergeant Drill Company. The air plant for this work has been divided into two sections, identical in capacity and type; one located at Thirty-second street and Eleventh avenue, New York, the other near Baldwin avenue, in Weehawken. A total of eight compressor units are to be used, four on each side of the river. All are now installed on their foundations. All are of the steam-driven cross-compound Corliss type, with duplex air ends. Six are low-pressure machines, designed for a terminal pressure of 50 pounds, with atmospheric intake, and each have a free air capacity of 4,000 cubic feet per minute. There are in addition two high-pressure compressors of the same type, each having a free air capacity of 920 cubic feet per minute, at a terminal pressure of 100 pounds from atmospheric intake, or 4,000 cubic feet per minute from 50 pounds intake (from the low-pressure machines), and a terminal pressure of 150 pounds. The low-pressure units have the Ingersoll-Sergeant positive air-thrown air inlet and discharge valves; the high-pressure machines have the well-known piston inlet valve. Three 400 horse-power water-tube boilers on each side of the river furnish steam for the compressing plants at 150 pounds pressure. The air is to be used for the same purposes and in the same manner as in the East River tunnels.

These four power plants represent in the aggregate the largest installation of air-compressing machinery ever made for general power purposes. Every refinement has been applied which could contribute to economy and reliability, for when the work is once under way no interruptions can be permitted. They represent the highest type of the centralized power plant, and their operation under the heavy service demands will be watched with the greatest interest.

Care of Pneumatic Tools in Shops.

Too many shops get an equipment of pneumatic tools and then let them take care of themselves. When they clog or fail to work satisfactorily they wonder what the trouble is and probably blame the maker of the tools. Now tools of this class are necessarily of high grade workmanship and contain some very delicate parts, but they will stand a large amount of very hard work if they are given anywhere near the amount of care they should receive. This is not only in the interest of the long life of the tools but the amount of work they will turn out, and this means the money they will save or earn during the year.

It would be difficult to pay too much attention to this point, and the easiest and most economical way is to have a system by which they will all be cared for regularly. Shops having a large number of air tools find it the best plan to have them turned into the tool room or some other designated place and regularly inspected and cleaned, the same as air brake apparatus. One favorite way is to stand the hammers, handle down, in coal oil or kerosene and let them stand over night. In the morning they are dipped in benzine and then blown out with air pressure. After this the tools should be thoroughly oiled and they are then ready for a large amount of hard work and are kept in good condition. Where a large number of tools are used it is a good plan to keep a few of them in the tool room all the time and to have them come in one after the other in regular rotation so that all receive care and attention every few days.

Drills can be readily cleaned by pouring oil (kerosene) into the handle or through the oil cock or both, and then following this with benzine, after which they should be carefully oiled again, first blowing out with air, the same as suggested for the hammers. Always blow out the cleaning oil and give a good supply of lubricating oil before using again. It doesn't pay to save lubricating oil with air tools of any kind. Adjust the ball bearings where they are provided, so as to take up lost motion and be sure that they are firmly held by lock nuts to prevent working loose or tightening up and binding when in use.

Oiling should receive careful attention,

and a few special suggestions may save future delays as well as repairs. Tools in constant use give better service if oiled once an hour with a good, light oil. Use some of the good oils provided for this and similar purposes, and be sure that it is not too heavy. The air used in the tools expands quite rapidly and this results in a lower temperature than in most machinery used in the shop so that a heavy oil will chill and be gummy.

The best way to oil hammers is to disconnect the hose from the hammer and oil through the air inlet. While doing this the thumb lever should be pressed and the hammer held in such a position that the oil will flow into the valve and other parts of the tool. Then, too, the nose piece should be oiled occasionally, as this will make the hammer work easier and last longer.

Drills are usually provided with oil cocks through which they should be liberally oiled at least once an hour if in constant use. This is especially recommended while the tool is new, and even after this the interval should not be too infrequent, say six times a day. The oil should also be put into or through the throttle handle once a day at least.

All air tools should have air strainers to prevent small particles of dust and dirt being carried into the working parts of the tools where it could easily do an immense amount of damage. Many cases where tools fail to give satisfaction from loss of power can be traced to the working parts being clogged with dirt from a failure to provide a strainer. The strainer nipple can be easily removed and the dirt blown out whenever it becomes necessary. In a drill this is sometimes placed in the handle, and the entire handle should be removed to clean it.

One of the most important points with an air tool is to be sure that it is getting its proper supply of air pressure. This should be from 80 to 100 pounds at the tool. In too many cases there will be sufficient pressure at the compressor and a lack of it at the tool. This is due to small piping or hose and to sharp bends as well as kinks in the pipe. Don't forget that a long hose or pipe must be larger than if a short one was used.

Use the best hose you can get and there is more satisfaction in the long run. It should of course be armored or wire covered to prevent kinks and keep the air supply from being shut off if a man accidentally or otherwise steps on the hose.

When using hammers be sure that the handle is always on tightly, as the tool may be seriously injured by allowing this to work loose. This controls the joint between the handle and the valve box and is of great importance.

In using always hold the riveter or hammer firmly against the work, as, if they are allowed to play in and out of the hammer, while in operation, it will seriously damage the hammer or riveter, as every blow should be delivered upon the end of the chisel and none on the forward end of the cylinder. There is no way of protecting against this injury except by care on the part of the operators and a little trouble to watch these points will result in the production of more and better work and in the longer life of the tool. Chisels and rivet sets should fit properly in the sockets, or there is further opportunity for loss of work and injury to tools.

In a general way these suggestions apply to all the makes of pneumatic tools in use, and by following along these lines you will secure more and better work from your equipment.

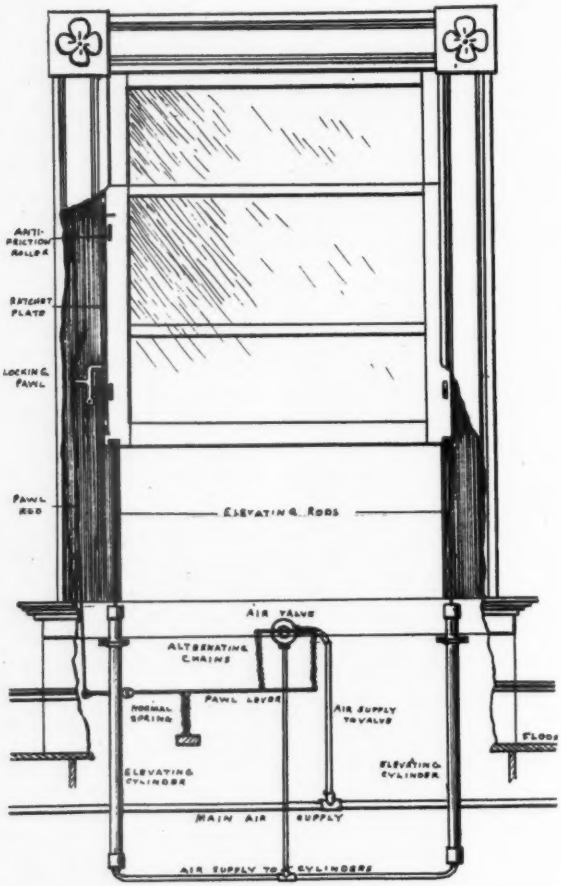
Unless your shop has graduated from the use of belting, which isn't likely in many railroad shops, it will pay to keep an eye on the way they are cut and laced. Belting is expensive and should have the best of care instead of being left to the tender mercies of any man who happens to run a lathe or navigate a drill press. It's a money-saving scheme to have one man look after the belts of the whole shop, to tighten them when necessary and otherwise look after them and their work. Shops that have tried this plan find that it works very nicely and save time on the part of machine hands, as well as saving money in belting ruined or injured.—*The Railroad Herald.*

Compressed Air for Operation of Windows or Doors.

A patent was granted to Thomas H. Davis and Arnold Davis, of West Haven, Conn., on June 14, 1904, for a device whereby any window or other vertically sliding partition may be opened, closed or retained at any desired point and that, without any fear of sudden closing from any cause, as it is securely locked in all

positions and cannot be moved unless the device is operated.

In a window, two elevating cylinders are fixed beneath the sash, at points equidistant from the vertical edges. Each is fitted with a piston, provided with a piston rod, which is attached to the lower



DAVIS AUTOMATIC WINDOW.

bar of the sash. Between these cylinders is placed an air valve and the necessary piping. Compressed air being admitted through the valve to the lower ends of the cylinders, even pressure is brought to bear on the sash and it is steadily raised to any desired position. The valve is of a three-way construction, by which means the cylinders may be connected to the main supply or to the open air, so that moved in one direction the window is caused to ascend by the action of compressed air on the pistons and in the other direction, to descend by its own weight, the rapidity of descent being controlled by the size of the exit air aperture. This valve is operated by a button, preferably placed in the panel immediately beneath the window. On the stem which connects the button with the valve is an arrangement of parts which controls the locking

and unlocking of the window, the principle of which consists in the engagement of a specially constructed pawl with a suitable ratchet plate operated by double levers.

The one movement of the button from the normal to the vertical position first unloads the window and then admits air to the cylinders, or, if moved to the horizontal position after unloading the window, connects the interior of the cylinders to the open air. This one movement of the button being all that is necessary for complete operation is one of the distinguishing features of the invention.

To prevent unpleasant rattling noises and liability to sticking, spring antifriction means are fixed in the vertical face of the sash, which engage with the inner face of the casing. These ensure smooth and easy vertical motion and prevent any lateral movement of the sash with relation to the casing.

By this device, all weights, cords, pulleys, springs, etc., are done away with. Its positive action and reliability and ever readiness for action would prove it to be a valuable acquisition to modern residences and public buildings.

Modern methods for production of compressed air reduce the cost to a minimum, and the construction of piping and engineering skill in fitting are such that chance of leakage may be considered out of the question.

This device was originally designed for the operation of railroad car windows, the difficulty of whose operation has so long been a recognized evil, but the possibilities appearing to be so great the inventors were granted a patent with claims which cover the application of the device to windows of all kinds and any vertically sliding member.

A New Franklin Air Compressor.

The illustration on page 3346 shows an air compressor recently furnished the Pennsylvania Railroad for its new shops at Altoona, Pa. It was designed and built by the Chicago Pneumatic Tool Company, at Franklin, Pa., and belongs to what is known as the C.S.C. class of machines, having compound steel cylinders and compound air cylinders. It is designed to run non-condensing with a boiler pressure of 100 pounds. The high and low pressure steam cylinders are 11 inches and 20 inches in diameter respectively, and air cylinders 11 inches and 18 inches, with a stroke of 24 inches. The capacity of the compressor is 700 cubic feet of free air at a speed of 100 revolutions per minute.

A glance at the illustration will show the massive and compact construction. All bearings are of generous proportions, pressure per square inch being reduced so as to avoid any tendency to heating. Bearings throughout are provided with removable shells or bronze bushings with provision for taking up wear.

The steam cylinders are provided with Meyer adjustable cut-off valves. Main steam valves are double ported, admitting of short ports and consequent reduction of clearance. High and low pressure main steam valves are balanced, reducing friction and wear.

Both air cylinders are provided with mechanically operated inlet valves of the Corliss type, placed in cylinder heads. These valves are actuated by the steam cut-off eccentrics, so that four eccentrics drive both steam and air valves.

The discharge valves are of the poppet type, valves proper being of cup shape, pressed out of sheet steel. The valve seats and guides are removable and accessible for inspection or renewal.

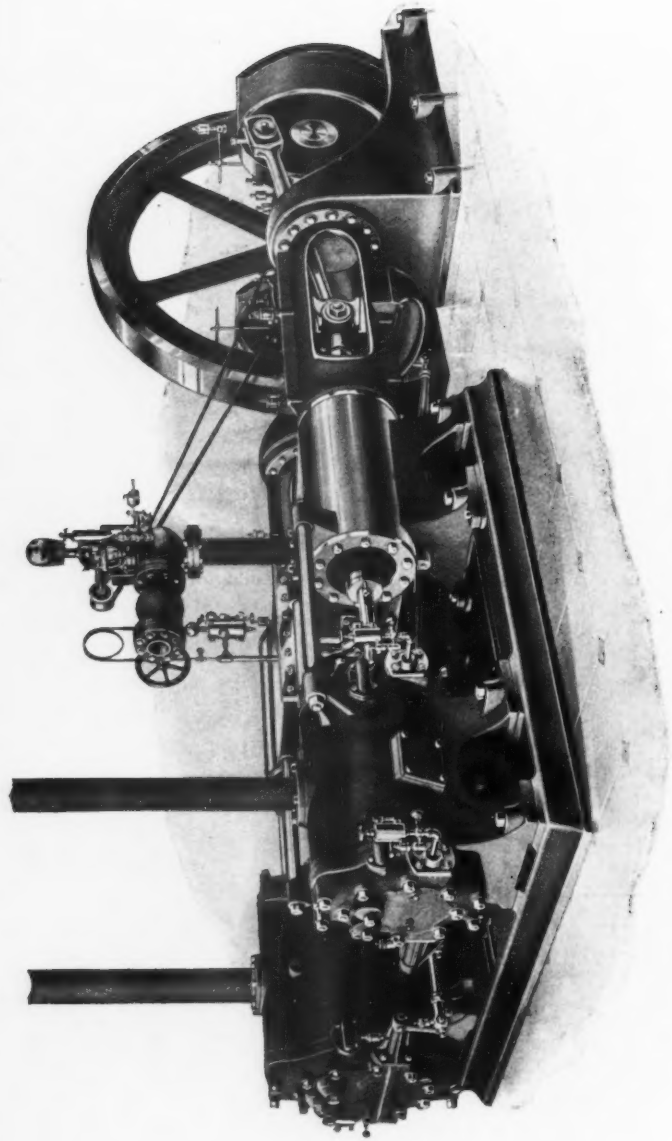
An intercooler, not shown in illustration, is provided between the high and low pressure air cylinders. This intercooler, being self-contained, can be placed in any location desired.

Owing to the small bore of cylinders and the proportionately long stroke, the percentage of clearance in air and steam cylinders is said to be very small, the advantages claimed being high volumetric efficiency and economy of steam.

A governor is furnished with a pressure regulator which is designed to bring the machine to a stop when receiver pressure has reached a desired amount, starting it again automatically upon a slight drop in receiver pressure. The governor is also supplied with a safety stop, which is to prevent the compressor from running away in case of accident to governor belt.

A rigid box-section sole-plate extends under the four cylinders to which they are doweled.

Further information may be obtained from the Chicago Pneumatic Tool Company, Fisher Building, Chicago, or No. 95 Liberty street, New York.



NEW FRANKLIN AIR COMPRESSOR.

An Ingenious and Effective Air-Lift Pump.

To force water to a height of 300 feet with an air pressure of less than 40 pounds per square inch seems at first sight an impossibility, because water pressure due to a head of 300 feet is 130 pounds per square inch. Nevertheless this can be and has been, done by the novel pump that we are about to describe. We are informed that the Patent Office at first rejected the application for a patent on this pump on the ground that it would be non-operative, and, as we doubt not that many engineers will likewise be inclined to ignore the claim that water can be forced up several hundred feet of pipe with a nominal air pressure, it seems worth while to explain the elementary principles involved.

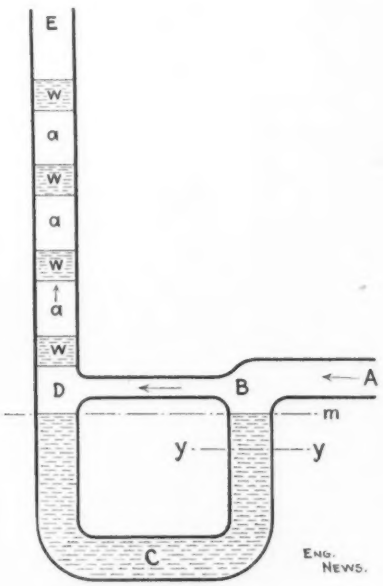


FIG. 1—MODEL SHOWING THE PRINCIPLE OF A NOVEL AND INGENIOUS AIR-LIFT PUMP.

Figure 1 shows a U-shaped tube filled with water up to the level *m*. Suppose compressed air to enter at *A*, at a pressure of, say, 10 pounds per square inch. We should expect this air to traverse the open tube in the line of the arrow from *B* to *D*, and then escape up the pen tube *D E* to the atmosphere. This, in fact, is what the examiner at the Patent Office believed would happen, nor were the attorneys for the patentee able to convince the examiner to the contrary by argument, due, we believe, to failure on the part of the attorneys themselves to understand the philosophy of the action of the pump. It was certain that the pump would work, for it had done so on a large scale in a mine where it had been installed. Furthermore, a glass model, as shown in Figure 1, could be made to deliver water at *E*, merely by blowing at *A*. The explanation of the phenomenon, as it seems to us, is as follows: Air entering at *A* has a pressure of, say, 10 pounds per square inch when it reaches the space *B* above the surface of the water. In passing through the tube from *B* to *D* the friction of the air on the sides of the tube reduces its pressure, so that when the air reaches the space *D* it has a pressure of, say, 9¾ pounds per square inch. We have, then, a pressure of 10 pounds per square inch acting downward upon the surface of the water at B, opposed by a pressure of 9¾ pounds per square inch at *D*. The result is that the water in the tube descends on one side to a level *y y*, while it ascends on the other side correspondingly. In round numbers the pressure due to the weight of a column of water is one-half pound per square inch for each foot of height of column; hence a difference of one-quarter pound per square inch between the air at *B* and the air at *D* would result in a difference in level of the water surfaces amounting to 6 inches in the opposite legs of the U-shaped tube. In other words, the water surface at *B* would descend 3 inches and that at *D* would rise 3 inches. This is what would occur were it not for the fact that when the column of water rises at *D*, it shuts off the air coming through the tube *D B*. The instant that this occurs the water begins to rise more rapidly, due to the now unbalanced pressure; and, almost immediately, the air in the pipe *B D* forces its way under a portion of the rising column of water in the pipe *D E*, thus separating a piston of water *w*. A repetition of this process occurs until the pipe *D E* is filled with alternate pistons of water, *w*, and pistons of air, *a*. The air pistons, as they ascend, are constantly expanding, due to the decreasing weight of water above them. Thus,

much of the energy of the compressed air is expanded in doing useful work.

Now we can see why it is that an air pressure of 40 pounds per square inch at the base of a column of water in the delivery pipe can support water and air pistons in a pipe 300 feet high; for, in fact, the compressed air is not lifting a solid mass of water 300 feet high. A pressure of 40 pounds per square inch can lift a solid mass of water only a trifle more than 17 feet high; hence, it follows that if we were to add together the lengths of all the water pistons in the pipe 300 feet high we should find the sum of their lengths equal to not more than 17 feet. In fact, it would be considerably less, for the friction of the ascending air and water on the sides of the pipe would act exactly like an additional weight of water, and

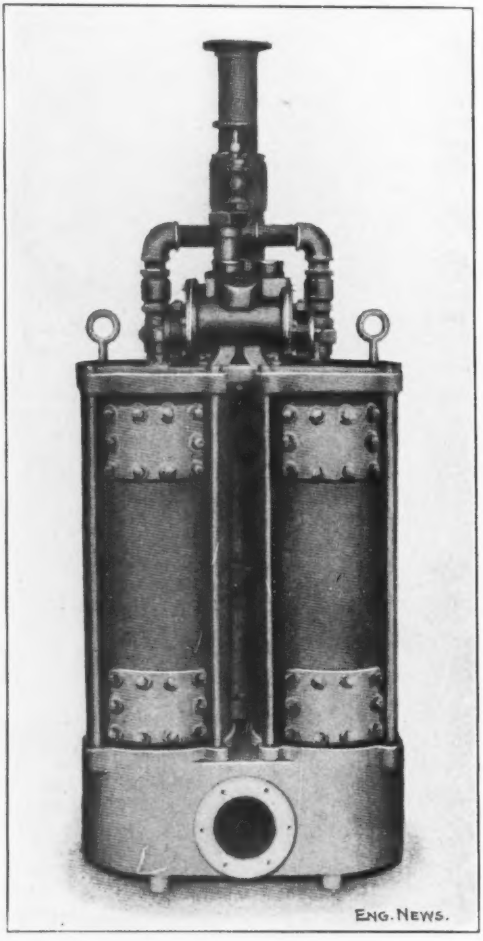


FIG. 2—ONE DESIGN OF A NOVEL DOUBLE AIR-LIFT PUMP.

thus reduce the actual weight of water in the pipe.

In the model, shown in Figure 1, there is no valve in the pipe, *B D*, but in practice such a valve is inserted, for with a valve there it is possible to throttle the air so as to get a difference of pressure between *B* and *D* that will produce the size of water and air pistons best suited for any given size of delivery pipe and lift under any given air pressure from the compressor. For a continuous delivery of water it would be necessary to submerge the model in water and to provide an intake valve. In practice it has been found desirable to combine two of the elements shown in Figure 1, so that one may be filled by "suction" while the other is being discharged by the air pressure. An automatic piston alternately connects each of the pump chambers with the exhaust and with the compression end of the air compressor. This necessitates two lines of pipe to the air compressor, but it results in economy of air as well as in ability to work with a pump that is not submerged. The general appearance of a double pump is shown in Figure 2.

The first published mention of the pump that we have just described is to be found in the Journal of the Assoc. Eng. Soc., October, 1900, p. 201, in an article by Edward A. Rix. No satisfactory description is given of the operation of the pump, but a table of tests of its efficiency is given. Using a delivery pipe 4 inches in diameter and with a lift of 105 feet, Mr. H. C. Behr, M. Am. Inst. Min. E., made twenty-one tests under varying air pressures. We have selected some of these tests as follows:

Air Pressure (above atmosphere) lbs. per sq. in.	Efficiency of pump.	Efficiency of compression.	Total efficiency.
41	42.5%	69.4%	25%
33¾	48.1%	73.8%	30.2%
29½	40.6%	76.2%	26 8%
29½	46.1%	76.7%	29.9%
24½	39.8%	79 5%	29.9%
24½	50.2%	79.5%	33.9%
23¾	40.4%	79.8%	27.4%
19	36.4%	82.6%	25.5%
14½	24.1%	85%	17.4%

It will be noted that the efficiency of the pump itself is high at all pressure except at the lowest pressure use, namely, 14½ pounds. The tests, however, show variations not accounted for by Mr. Behr. The last column of total efficiency was calculated by multiplying together the percentages in columns two and three and deducting 15 per cent. for friction of the compressor mechanism. Obviously the total efficiency may be materially increased by using a two-stage compound condensing air compressor plant.

This type of pump is especially adapted for mine pumping and for deep well pumping. Because of the fact that a low air pressure will force water up through many hundred feet, it follows that a comparatively light discharge pipe can be used, effecting a great saving in the cost of installation. For pumping the waters of coal mines which are usually charged with sulphuric acid, it would be practicable to use cheap bored wooden pipe instead of expensive and heavy iron pipe lagged with wood. Not only can a light piping be used, but the pump itself may be correspondingly light, thus effecting a material saving in first cost and in transportation. It should be always borne in mind that the pressures in the delivery pipe and in the pump cannot exceed the pressure of the compressed air; furthermore, that there can be no water hammer.

The air compressor itself need not be a large one, provided the quantity of water is not large even though the lift be a very great one. This is a feature especially worthy of consideration in mining work.

As above stated, the pump is not submerged as in the Pohlé air-lift system, and for this reason a well may be pumped down till it is practically dry. But, as is well known, when a well is pumped down low the flow of water into it is increased, due to the greater head of outside water. One of these pumps with a 1½-inch air pipe and a 4-inch discharge pipe is said to be in operation in San Mateo County, Cal., pumping 200 gallons per minute, with a lift of 210 feet, using a pressure of 30 pounds per square inch. Another of these pumps was exhibited in New York City, October 22, at the American Tract Society Building, where 100 gallons per minute were lifted 300 feet, using air pressure of 38 pounds per square inch.

The inventor of this pump is Mr. D. W. Starrett, of Oakland, Cal., and it is manufactured by The W. G. Leale Company, 119-121 Mission street, San Francisco, Cal. Mr. W. E. Crist, of No. 182 Broadway, New York, is the Eastern representative of the company.—*Engineering News.*

Vertical Compound Two-Stage Compressor.

The reasoning determining the design of this compressor included compactness, saving in floor space and foundations, elimination of wear due to gravity at an angle to line of motion, a proper relation of crank and fly-wheel effort, unobstructed access to all parts, an improved cooling system and as nearly as possible a self-contained machine.

The vertical design fulfills several of these requirements. A bed-plate with sufficient stability to be practically independent of its foundations and bearing the complete mechanism meets other stipulations. The only objections that can be urged against it are height and that the

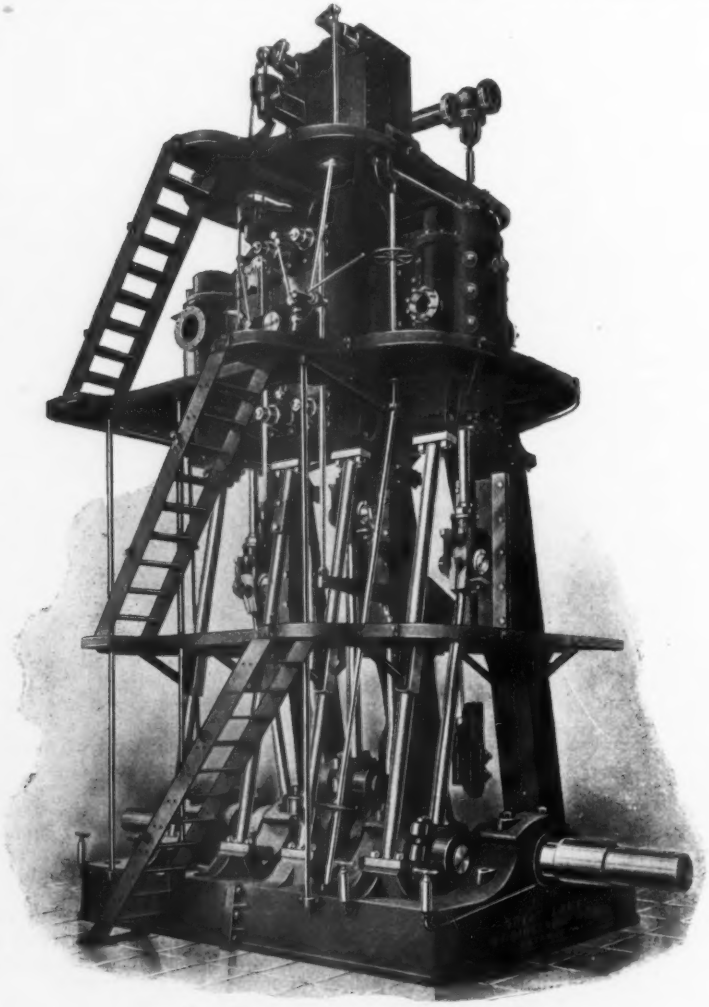


FIG. I—COMPOUND, TWO-STAGE, COMPRESSOR.

attendant has to mount a stair to go his rounds. Against the first objection, of course, is to be set saving in floor space and foundations, and the second has no sound basis and is not a real but imaginary inconvenience. The actual manipulation in starting and stopping can be done from the floor and the labor of climbing a stair is not to be set against the advantages gained. In the design under consideration, lateral wear in cylinders and

The prominent features of the design are simplicity and the liberality with which all wearing surfaces are treated. The crank shaft is of the built-up type; the air cranks outside and the steam crank in the centre. The air cranks are 180 degrees apart, with the steam crank 90 degrees from each; the steam crank during the period of compression is in position to fully utilize the steam effort and a mini-

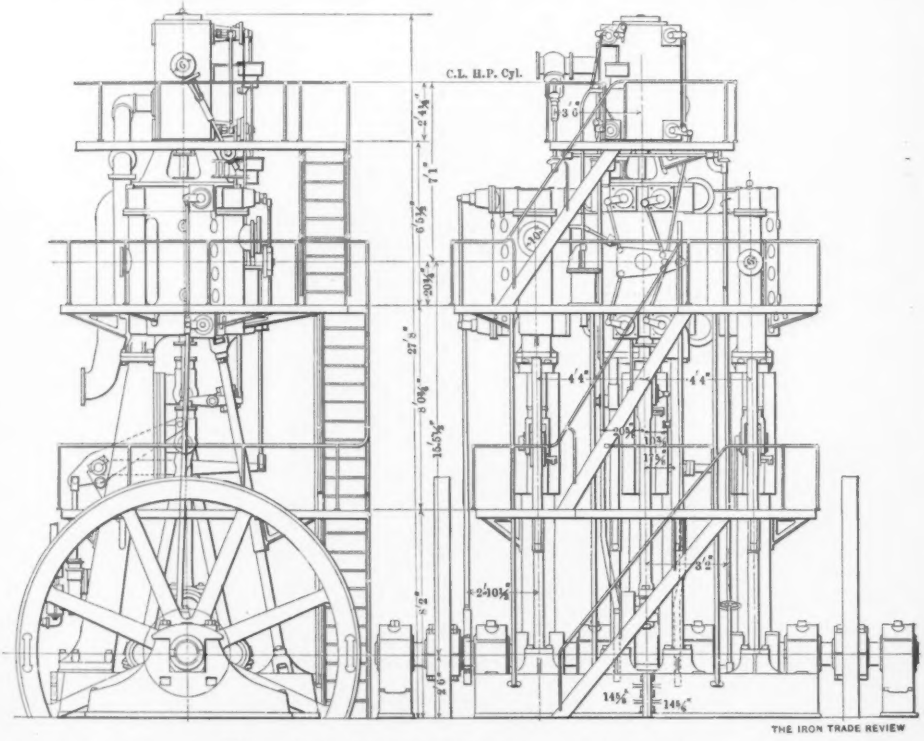


FIG. 2—END AND SIDE ELEVATIONS OF COMPRESSOR.

stuffing boxes is of course entirely eliminated and the alignment is undisturbed. Even the air valves are free from all wear except that inseparable from contact with their seats and this is in the line of motion and takes itself up indefinitely.

The whole machine, with all its working parts, can be seen at a glance; there is nothing out of sight or under the floor; the complete mechanism is in full view at all times.

mum weight of fly-wheel suffices for steady movement.

Lubrication of the main journals is forced by special cups feeding solid lubricant to the under side of the bearing.

The steam valve gear presents in itself no novel features, being of the double eccentric Corliss type, the high pressure fitted with releasing gear. The governing, however, is very simple. A small piston working in a vertical cylinder is loaded

with a weight equal to the air pressure acting under the piston and connected to the knock-off cams of the high-pressure gear. When the air pressure exceeds the load on the piston its upward movement changes the cutoff regulating the speed to a point equal to the demand. The air valves, together with the cooling system, are the results of long experiment. The low-pressure air inlet valve is mechanical and of the ordinary semi-rotary or Corliss type, as it has no function to perform except to open and close at predetermined intervals entirely independent of pressures. All other valves are of the poppet type, operated entirely by the air pressures. Flat seats are used throughout. Any valve, with its seat and all component parts, can be removed entirely from the heads, examined and replaced or renewed in from five to ten minutes.

The high-pressure suction valve has not a nut, set-screw, split pin or key in its construction, and with the bonnet removed and the valve cage drawn out the valve can be taken out of its guide and seat, replaced and secured in thirty seconds. The discharge valves are of nickel steel, as light as can be made and seat easily and quietly. The entire valve arrangement has had an experience of six years' actual use and the efficiency and cost of maintenance is found satisfactory.

In the usual arrangement of the cooling system the cooling water is admitted to the jacket at some convenient point and left to find its way out at some other convenient point regardless of proper circulation, the result is generally a cold belt extending from the inlet to the outlet openings with the remainder of the surface comparatively unaffected. In this design the cooling water is compelled to make the circuit of the cylinder three to four times depending upon the size of the cylinder, and there are no pockets or dead spaces. The intercooler is of liberal proportions and easily cools the air to a point below its original temperature. The cooling water is handled preferably by a pump operated by the machine itself so that the volume of cooling water may bear a con-

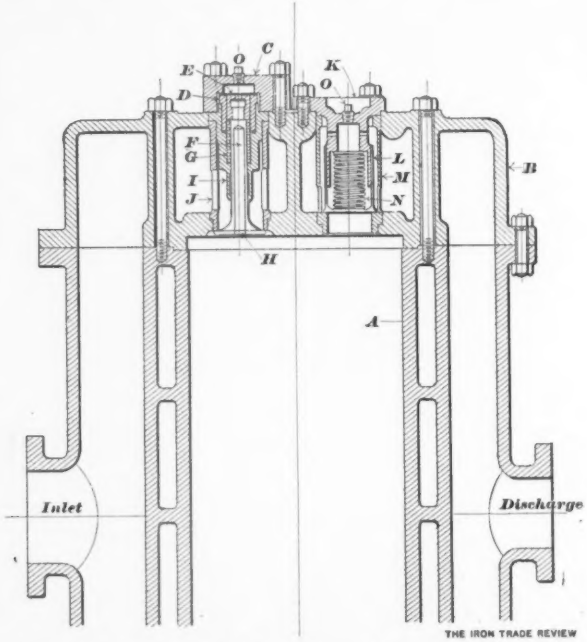


FIG. 3—SECTION OF HIGH PRESSURE AIR CYLINDER HEAD.

stant relation to the volume of air. The intercooler is placed in a vertical position, and the air and water cycles are as follows: Air from low-pressure cylinder to top of intercooler, from bottom of intercooler to high-pressure air cylinder; water from pump to bottom of high-pressure air jacket, from top of jacket to bottom of intercooler, from top of intercooler to bottom of low-pressure air jacket, from top of low-pressure jacket to overflow. It will be seen that both air and water travel in directions which would naturally result from their changing temperatures and with least possible effort. The total losses in the machine, including friction, leakages at valves and pistons, etc., amounts to only

Figure 3 shows a section of the high-pressure air cylinder and head illustrating valves, air and water passages. Beginning with the inlet valves it will be noted that by removing the bonnet the valve, seat and all parts can be drawn out together or the individual parts separately. *A* is the air cylinder and *B* the head. The valve *F* has a neck formed at the outer end into which a split collar *E* is fitted. The sleeve *D* slips freely over this, securely locking it in place on the valve stem. This split collar *E* forms the stop or shoulder for the spring G and thus avoids the use of any nuts, keys, set screws or other contrivances which may become loose and allow the valve to get adrift. The valve is

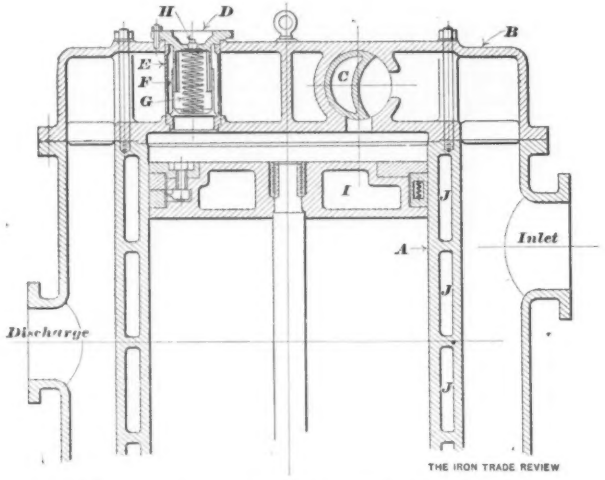


FIG. 4—SECTION THROUGH VALVES OF LOW-PRESSURE AIR CYLINDER.

5½ per cent. and furnishes ample justification for the design.

The machine illustrated has a capacity of 3,000 cubic feet of free air per minute, and some of the leading dimensions are: Steam cylinders, diameter 19 and 42 inches; air cylinders, diameters 34 and 19 inches; all cylinders, stroke 42 inches; flywheels, weight, total, 30,000 pounds; flywheels, diameter 14 feet; floor space, 14 by 21½ feet; height, total, 28 feet; weight, total, 220,000 pounds; crank shaft, diameter 11½ inches; crank pins, diameter 9½ inches; crank pins, length 10 inches; air pressure, 120 pounds; steam pressure, 140 pounds; intercooler surface, 1,340 square feet.

lightened as shown by drilling the stem out and plugging the inner end. The cage or seat *J* is of forged steel and extends clear across head. On this rests the forged guide *I* and the whole is securely clamped in place by the bonnet *C*. By removing the plug *O* the action of the valve can be observed at any time by inserting a bit of wire. The delivery valve cage *M* is arranged in the same manner and held in place by the bonnet *K* which also forms the guide for the cup-shaped valve *L* and the pocket for the spring *N*. Extreme lightness reduces the momentum in seating and permits a light and elastic spring, and to that end they are made of nickel steel and the section reduced to a point

that would ordinarily seem ridiculous, but as a matter of fact they have not shown a single failure. The form of discharge valve and guide leads to a very satisfactory dash-pot action practically relieving the spring of shock in opening and assisting in an easy closure. The arrangement of valve is peculiar to this design and is believed to be an improvement.

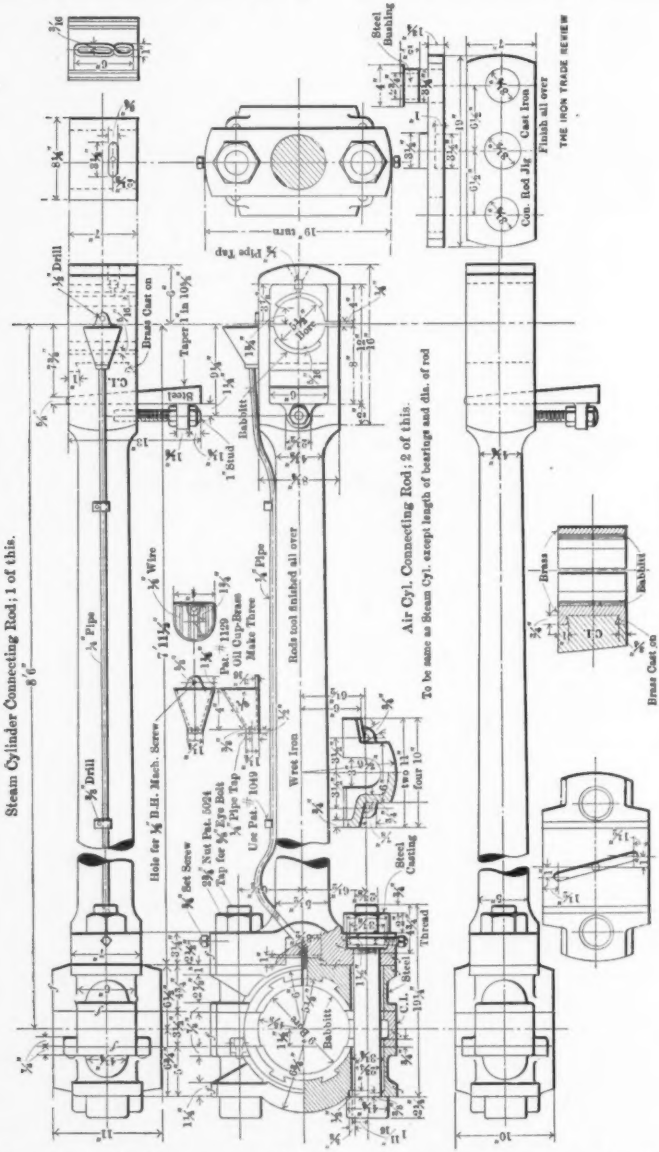

Steam Cylinder Connecting Rod; 1 of this.
Air Cyl. Connecting Rod; 2 of this.
To be same as Steam Cyl. except length of bearings and dia. of rod
Babbitt
Brass
Cast Iron
Steel Casting
Wrist Iron
Rods tool finished all over
THE IRON TRADE REVIEW

FIGURE 5—DETAILS OF CONNECTING RODS.

Figure 4 shows a section through valves of low-pressure air cylinder. *A* is the air cylinder, *B* the cylinder head, *C* the valve.

The discharge valve bonnet, cage and spring are indicated by *D, E, F* and *G. H* is the plug, *I* the piston and *J* the water jacket.

Figure 5 shows connecting rods complete and in detail, the crank end boxes are of steel and the upper end boxes of bronze, both lined with hard babbitt. The upper wedge gives a full bearing under box at all times; the crank end needs no detailed description. It is simply a genuine marine end, in fact the entire rod is taken bodily from a marine engine design from which scores of large marine engines have been built. The steam crosshead is identical with the air crossheads, except that the latter are of course threaded to the piston rods instead of keyed, in order to preserve clearance adjustment. The pin is taper fitted to crosshead and secured by a collar nut. A comb at the rear is the only oiling arrangement required and dips into an oil trough at bottom end of stroke, carrying the oil up over the slide face on the up stroke. Cups on the front are for the two connecting rod ends, one oiling through the uper butt above the pin and the other having a drip to a cup on rod. All fits are ground in and all crossheads are steel castings. This compressor is made by the Great Lakes Engineering Works of Detroit, Mich.—*The Iron Trade Review.*

The Philadelphia Filteration System.*

(TORRESDALE TUNNEL CONDUIT.)

In planning the new $26,000,000 filtered water supply for the city of Philadelphia, it was decided to locate the largest of the four filter plants on the Delaware River below Torresdale, and to take the filtered water from this plant by means of an inverted siphon to Lardner's Point, where it would be pumped into the distribution system. The works as planned consisted, therefore, of three parts, the filter plant, the inverted siphon and the pumping station. In the following paragraphs it is proposed to describe only the siphon in detail.

This is a 10½-foot tunnel 13,809 feet long, with a vertical shaft at each end, one shaft connecting with the clear water reservoir at Torresdale and the other with the pump well at Lardner's Point.

General Description. — Beginning at the Torresdale end, the conduit consists of a vertical shaft 10½ feet in diameter, which connects by a vertical curve with a circular tunnel also 10½ feet in diameter. At the opposite end of this tunnel a vertical curve connects it with a vertical shaft which is 10½ feet in diameter for part of its height and then funnels out to a diameter of 21 feet. The shaft at Torresdale is about 125 feet deep and that at Lardner's Point is about 105 feet deep; the exact length of the tunnel between centres of shaft is 13,809.18 feet, Shaft No. 11 being shifted slightly to the north.

The alignment and location of the tunnel are shown by Figure 1. It will be noted that the alignment is substantially parallel to the river, the tunnel being nowhere far from the river bank and in one place being under water. In profile the tunnel has an upgrade of 9 inches in 1,000 feet from Torresdale to Lardner's Point, the elevations at bottom of invert at these two points being respectively 99.41 and 89.07, the tunnel having been sunk 10 feet lower than the elevations shown on the plan, due to encountering treacherous material in Shaft No. 9. Figure 2 is a profile of the tunnel showing the character of the ground and the location of the various shafts, diamond drill borings, etc. The tunnel and the shafts are lined with brick masonry, except as noted farther on; the backing is of concrete throughout. This lining will be finished smooth to reduce friction. The carrying capacity of the tunnel is figured at 320,000,000 gallons per twenty-four hours under normal conditions, and it is expected that this can be increased to 350,000,000 gallons by increasing the speed of pumping and slightly lowering the level in the pump well at Lardner's Point.

Materials Penetrated.—The diameter of the geological strata along the line of the tunnel as determined by the borings is shown by the profile Figure 2. The borings were spaced 500 feet apart, but were staggered in plan, it not being decided at the time just on what route the tunnel would be located, so that they occurred only every 1,000 feet on the actual tunnel line. In general the ground along the line

*Illustrations reproduced through the courtesy of the *Engineering News*. Figs. 2, 3 and 4, which show the profile of the tunnel and general details of Shafts Nos. 1 and 11 were too large for these pages. They are shown on pages 498-9 of the December 1, 1904, issue of the *Engineering News*.

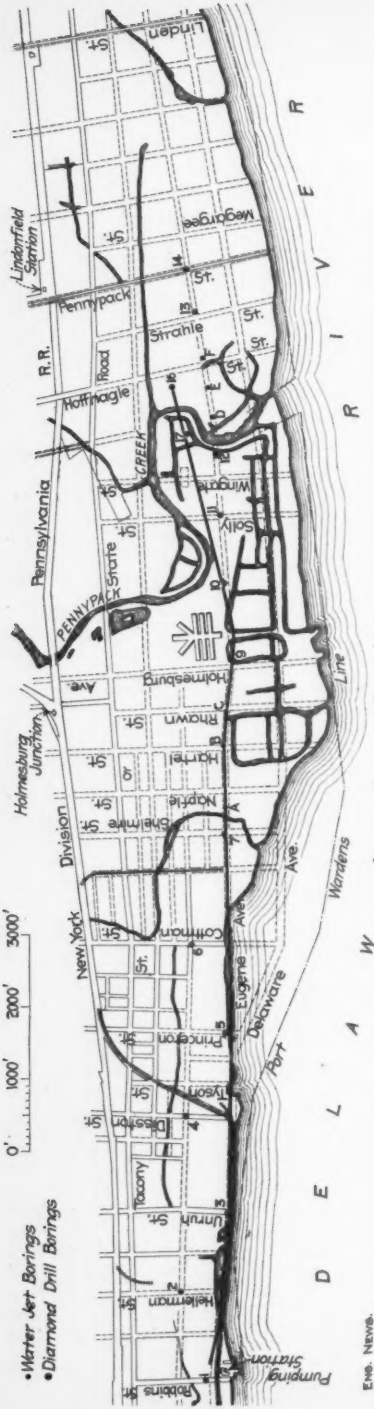


FIG. 1.—GENERAL PLAN OF TORRESDALE TUNNEL FOR THE PHILADELPHIA WATER SUPPLY.

of the tunnel is soft material—mud, sand, gravel and clay—overlying bedrock. The tunnel is entirely in rock, but the various working and permanent shafts had, of course, to penetrate the soft material. The greater part, about 86 per cent. of the rock pierced by the tunnel is a hard biotite gneiss, but there are considerable amounts of schistic and micacious rock, and in places this softer rock was disintegrated to about the consistency of mud. In some places the biotite gneiss was comparatively free from water and gave a dry excavation, but the softer rock carried large quantities of water. This inflow was sometimes concentrated in streams, but it often exuded in small drops over a rock surface of considerable area. The latter circumstance made the task of confining the water, particularly when it came in a shower from the roof, one of some difficulty.

Shafts.

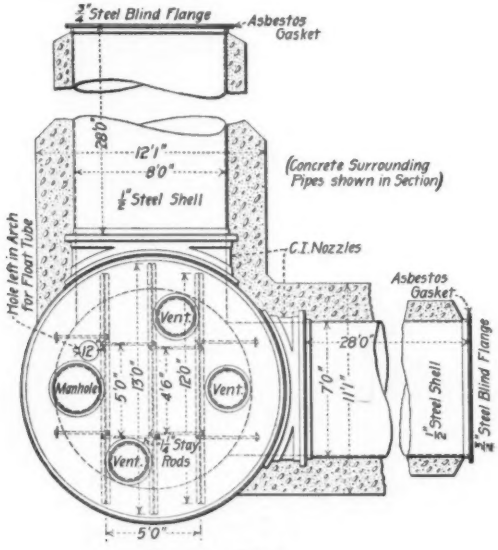
The engineers' plans called for the construction of the tunnel from eleven shafts. Two of these were to be permanent shafts and nine were to be working shafts, which were to be closed and filled on completion of the tunnel. These shafts were to be spaced from 1,000 feet to 1,700 feet apart, as shown by the profile, Figure 2. The adoption of so many shafts was for the purpose of hastening construction, it being deemed of the utmost importance to have the plant in operation at the earliest possible date.

Permanent Shafts.—The two permanent shafts forming a part of the siphon are Shafts No. 1 and No. 11, the former being located at the Torresdale end. These shafts are alike in their general construction, but differ in their dimensions. Each consists of a brick-lined steel curbing through the soft ground and into the bedrock for a part of the depth, and of a masonry-lined rock shaft for the remainder of their depth. The construction of the two shafts is shown by Figures 3 and 4.

Figure 3 shows the details of Shaft No. 1. This shaft is 10½ feet inside diameter throughout. The upper part, as will be seen, consists of a sheet steel cylinder, having a cast-iron shoe or cutting edge at its bottom and lined with 18 inches of brickwork. The steel cylinder penetrates the soft material and far enough into bedrock to be sealed against the inflow of

water from the soft material above the rock. Figure 5 is a detail of the cast-iron cutting edge; the other details of the cylinder and those of the top flooring, vents, manhole, ladder and platforms are clearly shown by the general drawings of Figure 3. The curbing of the shaft is pierced by an inlet pipe from the clear-water reservoir, and a second inlet is provided for when the occasion demands it.

The details of Shaft No. 11 are shown by Figure 4. This shaft is 10½ feet in diameter up to elevation + 164.5, and then funnels out to a diameter of 21 feet, which continues to the top. The steel shell being lined with brickwork. No lining was used elsewhere in the shaft except where necessary to sustain loose rock or to cut off large leaks. The working shafts were made about 10½ feet in diameter, and each was provided with the necessary framework for an elevator cage. At the bottom of each shaft a sump about 5 feet deep was cut in the rock to serve as a pump well for removing the drainage water from the adjacent workings. The section, Figure 6, shows a typical working shaft. After serving their purpose in the construction of the tunnel, the working shafts were filled flush with the ground



Top Plan.

which is lined with brick to form the upper curbing of the shaft is 24½ feet in outer diameter, and its bottom is a cast-iron cutting edge of the same construction as is used in Shaft No. 1. The other details of the shaft construction are fully shown by the drawings. The outlets of the shaft are two in number, the longer of which leads to the pump well.

Working Shafts.—Shafts No. 2 to No. 10, inclusive, were excavated for construction purposes. They were constructed like the permanent shafts by sinking steel cylinders through the soft material and sealing them into the rock, the cylinders surface. To carry this filling the tunnel lining was locally reinforced and two relieving arches were sprung across each shaft, as shown by Figure 6. The filling was required to be done with selected material deposited in 6-inch layers and rammed.

TUNNEL.

The tunnel conduit connecting the two end shafts is 13,809.18 feet long and 10½ feet inside diameter. It is lined throughout with brickwork, backed by a thickness of concrete sufficient to fill completely all the voids back of the brickwork. The

standard sections of brickwork and backing for different materials are shown by the drawings of Figure 7. All brickwork is laid in Portland cement mortar. Under the invert there is a 4-inch tile subdrain the full length of the tunnel. This drain is filled around with concrete, and all sumps at the feet of the working shafts are concrete filled. Where timbering is left in the work it is carefully packed around with the concrete backing and afterward the remaining voids are grouted.

Methods of Construction. Shafts.—The first work done was the sinking of the working shafts, and excavation began on all of these in December, 1901. At Shaft No. 4 an explosion of a charge of dynamite caused such an accident to the steel shell which had been partially sunk that it could not be recovered; a second shaft was accordingly started at this point in April, 1902. The dates of beginning the several shafts, their depths and the date of turning the first heading are given in the following tabular statement:

Shaft.	Depth, feet.	Commenced.	First Heading.
1	129	April 16, 1902	Nov. 6, 1902
2	121	Dec. 17, 1901	July 18, 1902
3	121	Nov. 26, 1901	April 2, 1902
4	111	March 19, 1902	July 17, 1902
5	113	Dec. 11, 1901	April 2, 1902
6	109	Dec. 4, 1901	April 4, 1902
7	107	Dec. 25, 1901	Aug. 12, 1902
8	109	Dec. 6, 1901	April 5, 1902
9	111	Dec. 14, 1901	April 11, 1902
10	106	Dec. 4, 1901	April 3, 1902
11	109	March 3, 1902	Oct. 10, 1902

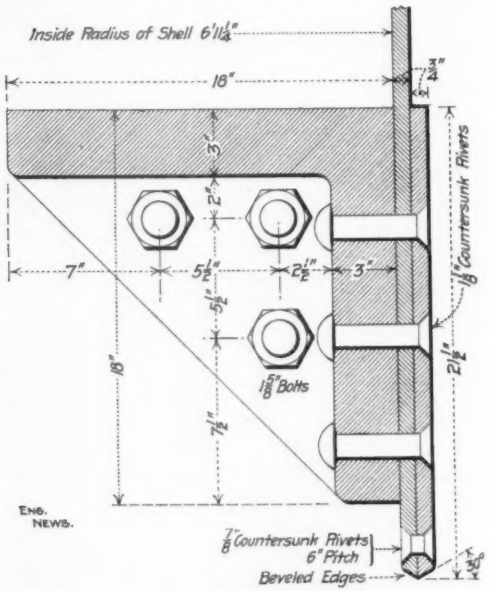


FIG. 5.—CROSS SECTION OF CAST-IRON CUTTING EDGE FOR SHAFT CURBING.

The method of driving the shafts was to sink a steel cylinder through the soft material and into the rock, where it was sealed against the entrance of water from the material above the cutting edge. These cylinders were sunk, except in two cases where compressed air was used, by means of open dredging, using for the most part orange-peel excavators. The rock was taken out by blasting in the usual manner. The sinking of the shells was troublesome in a few cases, owing to the

tipping of the shell. After sinking each shaft was equipped with an elevator cage and the usual other apparatus. While the contractors were left largely to their own devices in sinking the working shafts, they were compelled to obey certain restrictions in sinking the permanent shafts, Nos. I and II. It was essential that the curbing and lining of these shafts should be truly vertical and uniformly cylindrical. To insure the vertical sinking of the cylinder, use was made of the guiding frame-work shown by the drawings of Figure 8. These drawings explain themselves and need no further comment, except to state that they show the construction for Shaft

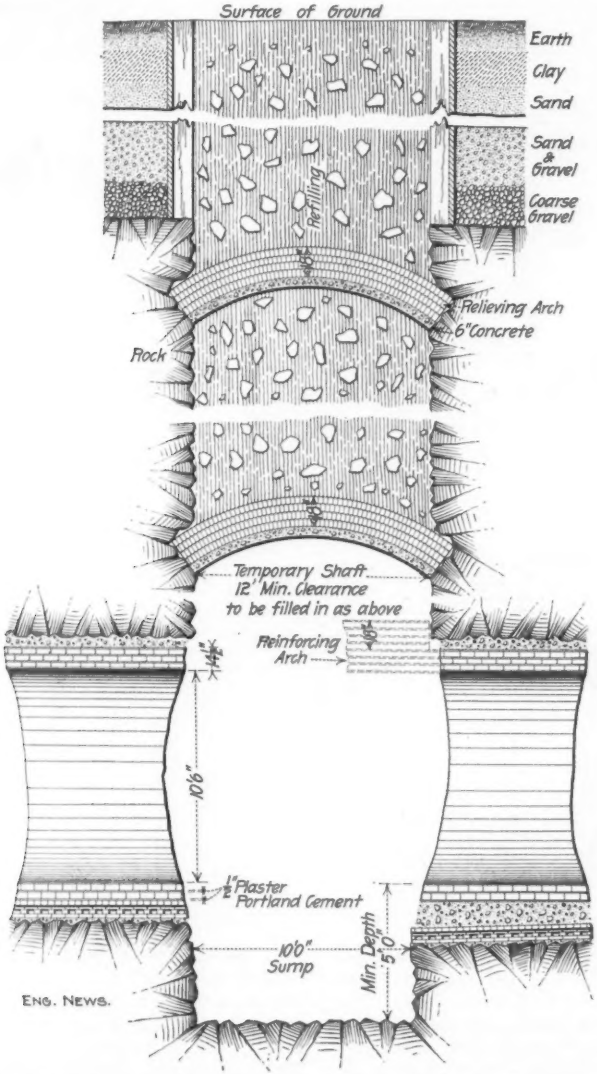


FIG. 6.—GENERAL DETAILS OF TYPICAL WORKING SHAFT, TORRESDALE TUNNEL.

No. 11, and that this construction was slightly modified by the smaller dimensions of Shaft No. 1.

Tunnel.—The tunnel is being excavated by the single wide heading and bench method, work being carried in both directions from each intermediate shaft and in one direction from the end shafts. The relative portions of the section taken out in heading and in bench are indicated by Figure 9. This drawing and the companion ones of Figure 10 and Figure 11 show the method of taking out the section. A wedge-shaped centre cut is made by means of the holes *A*. This cut is then enlarged by blasting the relief holes *B*. The side holes *C* and the roof holes *D* and *E* are then blasted, generally in one round. The blasting of these sets of holes open up the heading. The bench is then taken out by blasting the holes *F*.

Compressed air percussion drills are used for all the drilling. These are mounted on shafts for the heading work and on tripods for the bench work. The view, Figure 12, shows the arrangement of the drill mountings in one of the headings. The same feature is also indicated by Figures 10 and 11. The view, Figure 12, shows two drills mounted on each column, but in many of the headings two and three drills were worked by shifting

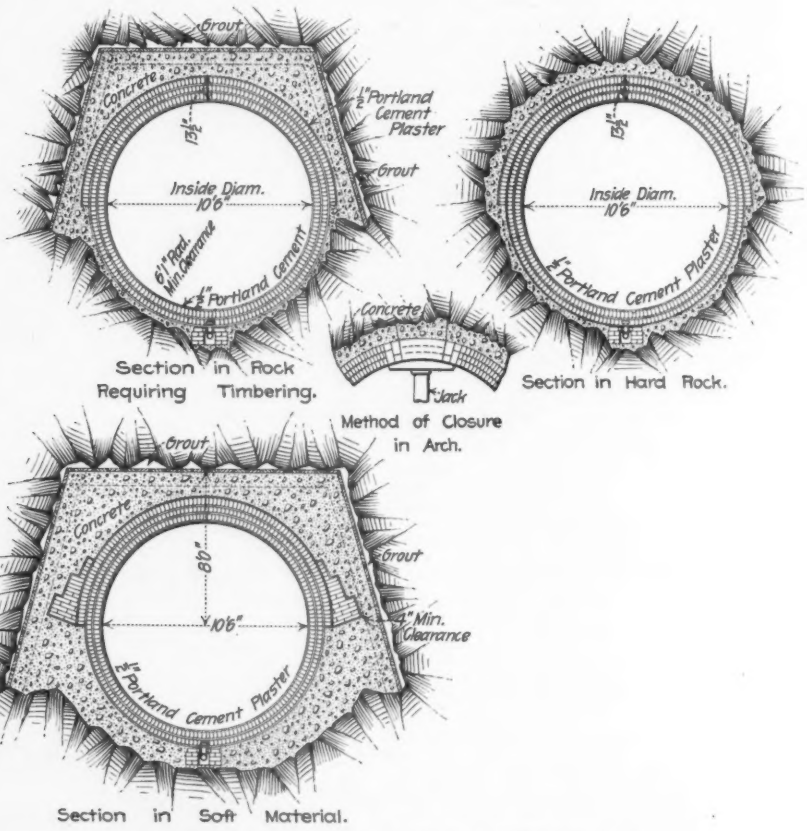


FIG. 7.—STANDARD SECTIONS OF TORRESDALE TUNNEL.

them on the columns, as indicated by Figures 10 and 11. Details of the labor force and time account are available for the excavation from fifteen headings. These have been furnished to us by Mr. H. B. Hanger, of the firm of Mason, Hoge & Co., of Frankfort, Ky., who are the contractors for Sections 1, 2 and 3, comprising Shafts 1 to 8, inclusive. These contractors employed two drills in eleven of the headings worked by them, and three drills in the other four headings. As a rule twenty-one holes were drilled for the heading cut and four holes were drilled for the bench cut. The heading holes were drilled 8 feet deep and the lift of rock removed by each blast was about 5½ feet. The charge was 4 pounds for each hole. The heading holes were fired in the order already noted. A blast was made at least every twenty hours. From four to five hours were required in mucking out and setting up the drills for each blast, and thirteen hours were occupied in drilling. The mucking proceeded continuously; seven muckers were employed in the heading and seven on the bench. These were worked in two ten-hour shifts.

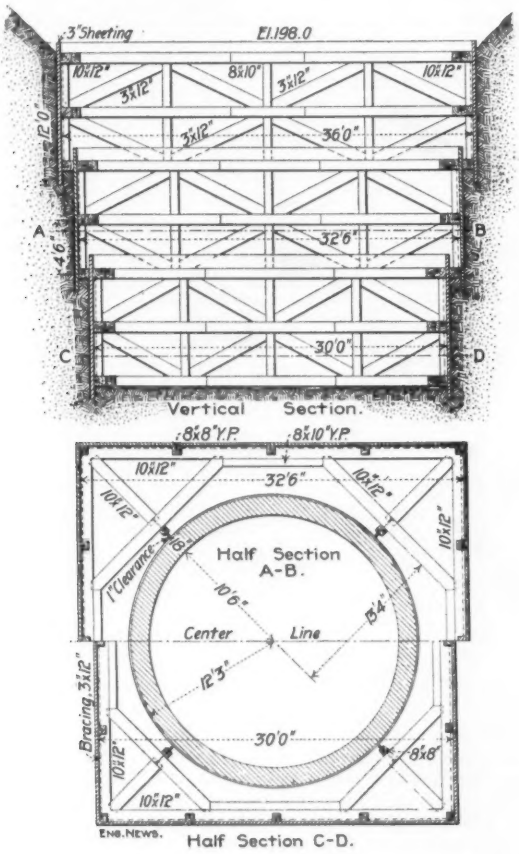


FIG. 8.—FRAME FOR GUIDING THE SINKING OF SHAFT CYLINDERS, TORRESDALE TUNNEL.

The most treacherous rock was found between Shafts 8 and 11, and considerable timbering was required. The character of this timbering varied with the conditions. At points where heavy falls of rock in large pieces followed the blasts the various styles of timbering shown by Figure 13 were employed. At other points, where the roof rock was more fragmentary in character, a rather close and tight segmental roof timbering was adopted.

The lining construction calls for brief description only. The first operation was the construction of the concrete saddle for the lower half of the brick lining. Mounted centres were set up and fastened at the proper height above the floor of the

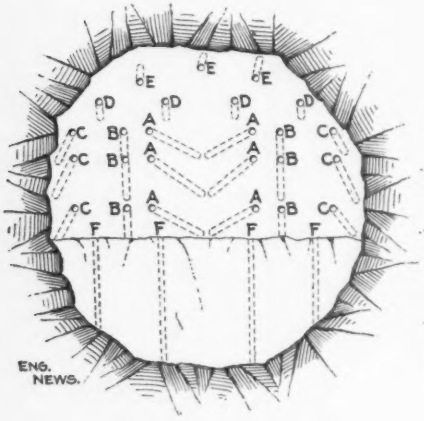


FIG. 9.—END VIEW OF HEADING SHOWING DRILL HOLES.

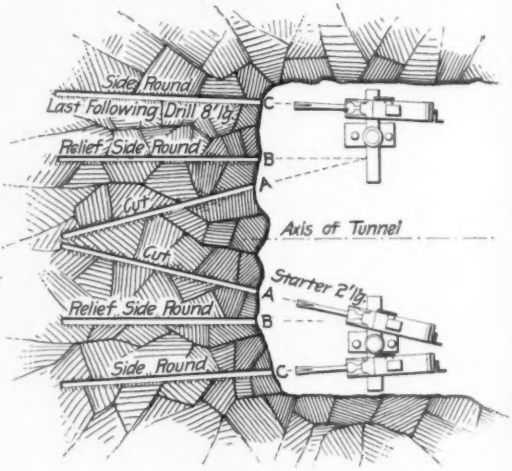


FIG. 10.—PLAN OF HEADING SHOWING DRILL HOLES.

excavation. These centres were then lagged in convenient sections and the concrete filled behind the lagging. The lagging was begun at the bottom and was placed a piece or two at a time and blocked up against the centres. The concreting then proceeded until additional lagging pieces were needed. Figure 14 shows a section of tunnel with the centres and lagging for the saddle in place. After the concrete had set and the lagging was removed, the upper surface of the saddle was plastered with a sufficient coating of cement mortar to fill all roughness and give a smooth bearing to the invert brickwork. This was then built up in the usual manner. The construction of the roof arch then followed. The view, Figure 15, shows the centering of this work, and, as will be observed, this view happens to be in a portion of the tunnel where the rock required heavy timbering. The brickwork of the roof arch was constructed in the regular way, and about all that needs to be noted is that the concrete backing or filling proceeded with the progress of the brickwork. This provision was strictly insisted upon by the engineers.

Materials and Workmanship.

The principal materials used in constructing the tunnel and shafts were concrete, brick, and cast iron and steel tubing.

Concrete.—The concrete employed was composed of 1 part Portland cement, 3 parts sand and 5 parts broken stone or gravel. As a matter of fact, very little gravel concrete was used. The specifications for the cement were rather strict, and we quote them as follows:

"Portland cement shall have a specific gravity of not less than 3.1 and shall leave by weight a residue of not more than 1 per cent. on a No. 50 sieve, 10 per cent. on a No. 100 sieve, and 25 per cent. on a No. 200 sieve. The sieves shall be made of brass wire cloth, having approximately 2,400, 10,200 and 35,700 meshes per square inch respectively, the diameters of

the wires being respectively 0.009, 0.0045 and 0.002 inches. Pats of neat cement ½ inch thick with thin edges after hard set, when immersed in water maintained at a

1.75 per cent. of anhydrous sulphuric acid (SO_3). It shall require at least twenty minutes to develop the "initial" set, this being determined by means of the Vicat

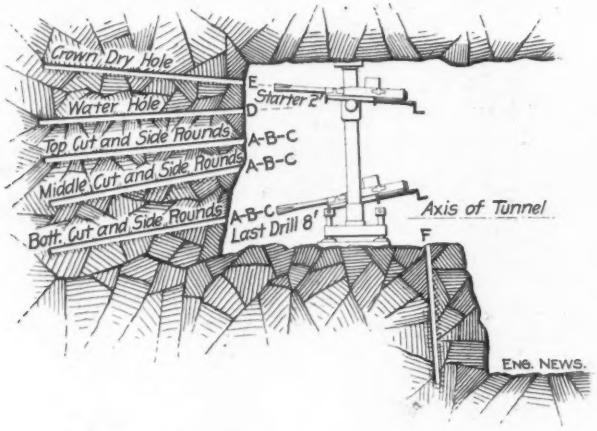


FIG. 11.—LONGITUDINAL SECTION OF HEADING SHOWING DRILL HOLES.

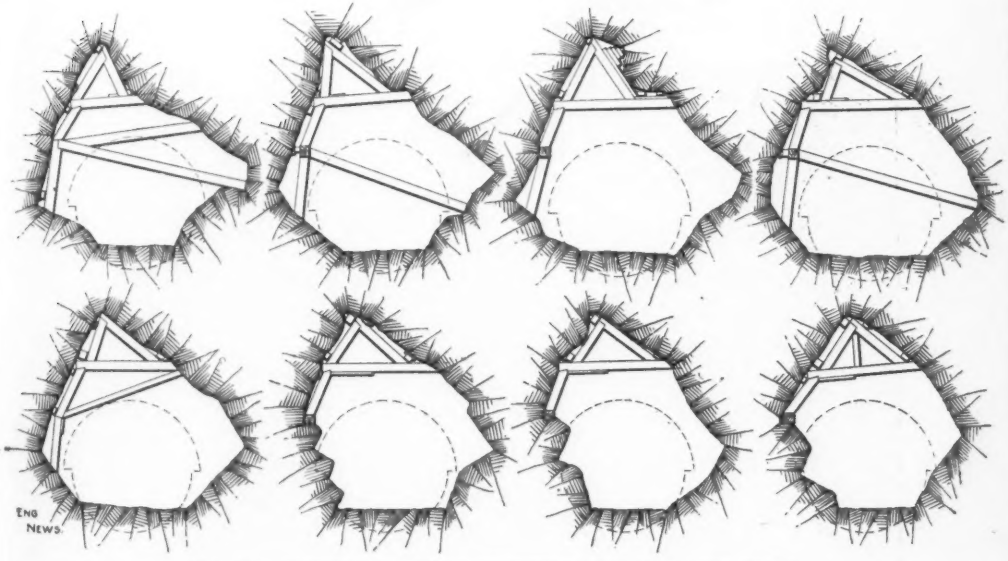


FIG. 13.—SECTIONS SHOWING TIMBERING OF LARGE ROCK FALLS.

temperature of 175 degrees F. shall remain firm and hard, and show no signs of swelling, "checking" or disintegration. The cement shall contain not more than

needle from pats of neat cement of normal consistency, the temperature being between 60 degrees and 70 degrees F. Briquettes of 1 square inch in cross section shall

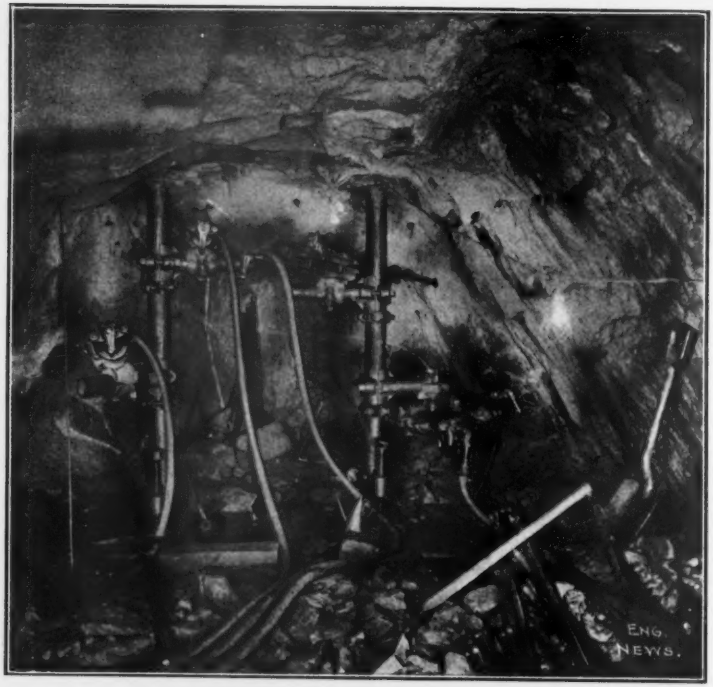


FIG. 12.—VIEW INSIDE HEADING SHOWING DRILLS AT WORK ON HEADING CUT.

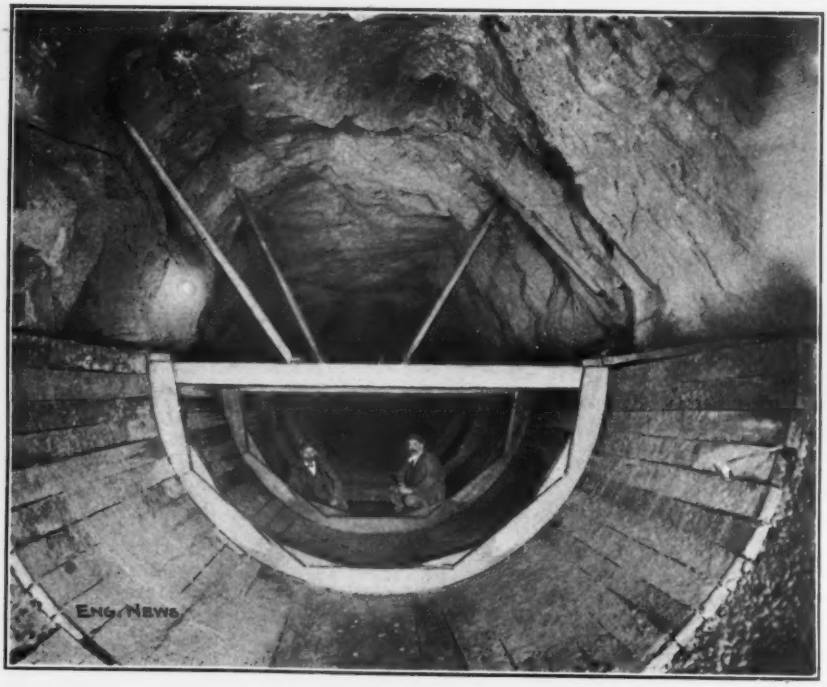


FIG. 14.—VIEW INSIDE TUNNEL SHOWING FORMS FOR CONCRETE SADDLE FOR LINING.

develop the following ultimate tensile strengths:

Age.	Strength, lbs.
24 hours (in water after "hard" set), neat cement	175
7 days (1 day in air, 6 days in water), neat cement	500
28 days (1 day in air, 27 days in water), neat cement	600
7 days (1 day in air, 6 days in water), 1 cement to 3 standard quartz sand	170
28 days (1 day in air, 27 days in water), 1 cement to 3 standard quartz sand	240

be screened out, and any sand containing more than 3 per cent. by weight of loam, clay, dirt or other impurities was forbidden. For broken stone granite, trap or other hard rock was specified. All pieces less than ¼ inch in size and all larger than 1½ inches were required to be screened out. The material between these sizes was required to be "graded from fine to coarse." Either machine mixing in cubical mixers or hand mixing was allowed. The deposition of the concrete was required to be in 6-inch rammed layers. Exposed surfaces were to be kept wet during setting, and junctions of old and new concrete were required to be

FIG. 15.—VIEW INSIDE TUNNEL SHOWING CENTRES AND STAGING FOR CONSTRUCTING ROOF ARCH.

The sand was specified as is usual to be clean and sharp, and graded in size. All parts larger than ¼ inch were required to made by washing the older surface, and, if requested, by slushing it with neat cement grout.

Brick Masonry.—Only high grade bricks were allowed, and they were required to be laid in a 1 Portland cement, 3 sand mortar. Each brick was required to be wetted before laying, and old brickwork was required to be cleaned and wetted before laying new. Connections were required to be made by leaving the old work racked back, toothing not being allowed. The specification for the brickwork of the lining was as follows:

"The bricks shall be laid with their lengths parallel to the axis of the tunnel, each longitudinal line of brick breaking joints with the adjoining line. No headers shall be used in the work. The bricks with the smoothest edges shall be selected to form the inside ring. The collar joints between the rings shall not be less than ⅜ inch nor more than ½ inch. The last five courses of brick at the crown of the arch shall be laid with dry tight joints and then grouted with neat cement grout."

The specifications for cast-iron, steel, stonework, etc., were those employed generally for first-class work of similar character, and they will not be given.

ENGINEERS AND CONTRACTORS.

The construction of the Torresdale tunnel has been prosecuted under the direction of the following engineers and contractors: Chief engineer in charge of the work appurtenant to the improvement of the water supply, John W. Hill, M. Am. Soc. C. E. Contract No. 14, Torresdale Conduit, first assistant engineer in charge to March 1, 1902, Richard I. D. Ashbridge, Assoc. M. Am. Soc. C. E.; since March 1, 1902, T. Nelson Spencer, Assoc. M. Am. Soc., C. E. Second assistant engineers, Charles P. Bower to May 10, 1903; S. M. Purdy to July 1, 1903; Moriz Bernstein since July 16, 1903; William H. Thorpe since May 1, 1903. Third assistant engineers, Frank McHugh since July 23, 1903; John D. Quinn since May 20, 1903. Mining inspectors, A. York Smith to October, 1902; George Hein since October 18, 1902; John E. Peters, head masonry inspector. Contractor, Mr. Daniel J. McNichol, Philadelphia, Pa. Subcontractors, Section No. 1, Shafts Nos. 1, 2, 3 and 4; Section No. 2, Shafts Nos. 5 and 6, and Section No. 3, Shafts Nos. 7 and 8, Mason, Hoge & Co., Frankfort, Ky. Section No. 4, Shafts Nos. 9, 10 and 11, managed by Contractor D. J. McNichol, under the supervision of J. Clifford Fitch to March 2, 1903, and since March 2, 1903, by L. G. Burleigh.

The total cost of the tunnel will be about $1,350,000.

Twenty-five Years in the Rock Drill Business and Still He Looks Young.

Rock drill business is one of hard knocks. Few survive a very long period after an experience in the selling line. There is one case on record where a rock drill man resigned his post and went to a foreign country as a missionary. It has been said that the record of the business shows no other instance where a rock drill man went wrong in that particular direction. It is said they usually go the other way, and the case referred to has been explained on the ground that he was driven

MR. GEORGE A. HOWELLS.

to it. We illustrate in this issue the photograph of Mr. George A. Howells, who is as young as he looks, and who has the remarkable record of holding his own after twenty-five years' experience in the drill business.

The rock drill and air compressor trade was largely represented at a gathering of associates and friends of Mr. Howells at the office of the Rand Drill Company, in New York, on January 5. The occasion marked the twenty-fifth consecutive anniversary of Mr. Howells' connection with that company.

During the afternoon Mr. Howells was presented with a handsome loving cup by the officials of the company.

Notes.

Postmaster Wilcox, of New York, declared, on taking office the first of the year, that an extension of the pneumatic tube service in that city was urgently needed.

The Cleveland Pneumatic Tool Co., of Cleveland, O., has issued two calendars of unusual artistic merit. Two beautiful women's faces make them attractive souvenirs.

A commission appointed by the Postmaster General to investigate the question of pneumatic tube mail service, is considering the conditions at Pittsburg, St. Paul, Minneapolis, Cleveland, Cincinnati, Buffalo and San Francisco.

It is reported that the Erie Railroad intends equipping its New York division, a stretch of 87 miles between Jersey City and Port Jervis, with pneumatic signals. This is an example set by most of the prominent railways running into Greater New York.

In describing the Twin City Rapid Transit power station for the traction system between St. Paul and Minneapolis, the *Electrical World* tells of a lubrication system from an overhead tank, the oil being distributed by means of compressed air at 40 pounds pressure.

One of the latest companies interested in the manufacture and sale of pneumatic machinery is the Atlas Pneumatic Tool Co., of Findlay, O. The incorporators are M. M. Carr, E. W. Allen, M. A. Thomas, Fred C. Veon, of that city, and J. D. Hare, of Upper Sandusky.

A central hot-water heating system is being operated in the city of Columbus, O., by the Columbus Public Service Co. Hot water is supplied to office buildings and residences with considerable success. A compressed air line runs in the same trench with the heating mains, and that power is used for operating the supply system.

A diary containing some valuable engineering information in addition to that usually found in such books is an appropriate New Year's gift of the Westinghouse Companies' Publishing Department. These diaries will be specially valuable to the man who desires to have the information in a book of pocket size.

Some trouble was occasioned in the operation of the pneumatic tube system at Chicago, Ill., by the condensation of moisture in the tubes. The rapid movement of the carriages through the tubes causes a certain amount of friction. The heated tube condenses the moisture in the air and in some cases the water penetrated to the interior of the carriages holding the mail. This trouble has since been obviated by the use of water-tight carriages.

J. T. Blachett has secured the English patent rights for certain improvements to a rock drill. It provides for a construction whereby, when the drill or cutting tool meets an unduly hard substance or great resistance, it is automatically drawn back in the bore-hole and automatically fed forward again, these operations being repeated until the obstruction is removed, whereupon the drill spindle and screw bar will be automatically fed forward again as in normal working.

An air receiver forms an important part of an air compressing plant. It should be placed at a distance not greater than 50 feet from the compressor. It serves a useful purpose by receiving the air in pulsations from the compressor, and delivering it in an even, steady flow. The air as it comes from the compressor also contains more or less moisture which collects in the receiver and may be drawn off by means of the drain-cocks which are provided with each receiver.—*The Practical Engineer.*

There is no more tedious and expensive operation in the many branches of agriculture than the picking of cotton. This labor is entirely performed by hand, and requires a large force of laborers in order to

harvest a crop when ripe. Many attempts have been made for performing this work by mechanical means, but with little success. The most practical device yet designed was a compressed-air apparatus, which sucked the cotton from the plants on passing down the rows, but this machine had many objectionable features and was abandoned. A practical invention which will pick cotton more cheaply than by hand will return to the successful inventor a goodly income.—*American Inventor.*

Two catalogs were issued by the Ingersoll-Sergeant Drill Co. the first of the year. One is a 1905 edition of Catalog No. 35, describing "Air Compressors." It contains much the same material as the previous edition of this catalog, but has some additional illustrations of the compressor plants of the Cleveland Stone Co. at North Amherst, O., and the Mare Island Navy Yard. Inter- and after-coolers also receive attention. The other new catalog is No. 52, "Coal Mining Machinery." It deals quite extensively with the question of machine mining and advances a number of arguments in favor of the compressed air machines. The "New Ingersoll" coal cutter is described and illustrated. Other Ingersoll-Sergeant machinery of service to the coal miner receives attention.

English patents have been granted to A. Reichwald, of London, for a percussive rock drill having a spirally-grooved spindle projecting into the cylinder from one end thereof, and passing into the piston through a nut fixed and carried thereby, so that as the tool-carrying piston is reciprocated in a forward direction, it receives the twist due to the rifle-bar, while at the retrograde motion the rifle-bar is itself revolved about its axis through a small angle, so that the drill after each blow is turned through this angle. The present invention refers to improvements in the construction of the detent mechanism by which the rifle-bar is locked during the motion of the piston in one direction. The slots receive the sliding pawls, which are recessed on their inner ends to receive springs bearing against the bottom of the slots. These springs force the pawls outward against ratchet-teeth, formed in the casing which receives the head of the rifle-bar. The inclination of the teeth of the ratchet is such that the head of the rifle-bar can be moved with a step-by-step motion, while the co-action of the pawls and the teeth prevent motion in the reverse direction, and one of the sliding pawls is always in engagement.

The greatest innovation in automobile construction shown at the recent French salon was a compressed air brake for automobiles, which, besides being a brake, has other qualities which render it exceedingly valuable. By it the engine can be turned over by the aid of the compressed air, and the clutches thrown in by the same system. This attachment, if such it can be called, was found on but one car, the Mercedes.

The system of operation is exceedingly simple. By means of gear wheels a small pump quickly builds up a powerful compression inside a metal chamber. When the pressure is sufficient a valve comes into operation and cuts off the entrance. It is opened again as soon as some of the air is withdrawn, and the filling process begins once more.

This force is regulated by a small lever on the steering wheel. A slight movement of this lever and the clutch is thrown out; a little stronger pressure and four brakes are brought into operation, two on the front hubs and two on the back. In case of a slack tire it is only necessary to connect the pump with the tire valve and the tire is blown up in an instant. But this, of course, is only a minor feature of the invention. The central point to be considered is the fact that it increases the driver's control over the brakes and clutch, and consequently over the entire machine, at least 50 per cent.—*Ex.*

W. G. Barnsley writes: "Please suggest a method of preventing the freezing of a pump that is driven by compressed air. The pump is fixed in a pit."

The pump is, presumably, driven by a compressed air engine, in which the compressed air is expanded in a cylinder like that of a steam engine. Of the chief difficulties that are met with in this type of engine one is the presence of the moisture that is held in suspension in the atmos-

phere. If the compressed air, when it enters the engine cylinder, is saturated with moisture, a certain amount of the vapor is condensed and thrown down while the expanding air is driving the pump, and as the expansion of the air continues the temperature is still further reduced, and the liquid freezes and accumulates in the form of snow and ice around the valves and passages, ultimately completely choking the exhaust pipe. Should the exhaust leave the engine at a pressure that is much above the pressure of the atmosphere, the sudden expansion of the compressed exhaust would so suddenly reduce the temperature that the suspended moisture would immediately be converted into ice, while still in the exhaust pipe. Try the plan of readjusting the valves so that the cut-off would occur a little earlier than it does now, thus giving a greater expansion, so that the air may exhaust at a lower pressure. Should this device not remedy the fault, the only method of overcoming the difficulty is to remove as much as possible of the moisture, either before or after compression. Various means have been devised for absorbing the moisture of the air, such as passing it over chloride of calcium or sulphuric acid, or some such powerful absorbent of water; but this method is only applicable to small machines, because of the trouble that would be experienced in changing the material and evaporating the water that has been absorbed. The only practical method is to deprive the air completely of its mechanically suspended moisture by condensation and deposition in the cooling process after compression, as adopted in all cold-air refrigerating machines. Nothing that can be mixed with the lubricating oil will prevent the freezing of the moisture in the exhaust pipe. Further information concerning the plant, together with a rough sketch, would perhaps enable the writer to give more advice.—*L'Ingenieur.*

The idea of compressing the air to be used in rock drills, at the working face, has borne fruit in another direction. An English inventor has followed the method employed in the Siemens and Gardner electric percussion drills, and has arranged a small compressor that can easily be carried about to be placed on the floor of the mine, in the immediate neighborhood of the hole to be drilled, the compressor having an electric motor attached to it and working it, while from the two ends of the compressor cylinder two hose pipes are taken to the drill. The drill itself is very similar to the usual air drill. It has a piston and rod, to which the drill is attached, and there are valves in front and behind the piston, admitting air to force the piston forward and to drive it back, and the usual rifled groove to give the twisting motion to the drill, a spring to cushion the drill behind and the usual hand-feed gear. The main lines of the arrangement, compressing the air near the working face and using the compressed air to work the drill, have long been used in Germany, with considerable success. The novelty of the present arrangement, as I understand it, is that the same air is used over and over again, and there is no storage of compressed air. The suction side of the compressor is the exhaust side of the drill, and the push given to the piston of the drill is the push given to the piston of the air compressor, the push being transmitted by the air. The arrangement presents certain advantages, as, for instance, the trouble of the freezing of the moisture carried by the air into the parts of the drill should be got rid of by expansion of the air also due to the heat generated in compression will act in the direction in which it is wanted, in the direction in which the work has to be done. It should add to the push given to the piston of the drill, and so increase the efficiency of the whole system, by cooling also that takes place, owing to the larger space occupied by the air after the drill piston has moved forward, and the compressor piston has also begun to recede, will again be in the direction of greater efficiency. It is always unwise to accept statements of what an apparatus has done in granite, or, in fact, under any but actual working conditions, and therefore I do not lay any stress on the tests stated to have been made, but the apparatus has, in my opinion, the makings of efficiency, if the details are properly carried out. Remembering that with the ordinary air drill 12-horse-power is required in the compressor on the surface to drill holes than can be drilled with 1 to 2-horse-power, there is great room for invention. Compressing by electric motor does away with the great losses by leakage of air in transmission and the closed air circuit arranged would appear also to get rid of a good many of the other losses.—SYDNEY F. WALKER in the *Electrical Review.*

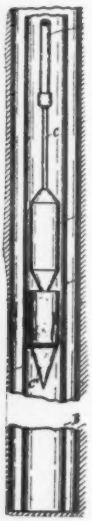
INDEX.

	PAGE
Another Advertising Contest	3332
An Independent Valve Gear	3339
An Ingenious and Effective Air Lift Pump	3347
Care of Pneumatic Tools in Shops	3342
Central Compressed Air Power Plant of the St. Louis Terminal Station	3332
Compressd Air on the Modern Railway	3331
Compressed Air for Operation of Windows or Doors	3343
Compressed Air Power Plants for the Pennsylvania Railroad Tunnel	3341
Compressed Air Pump	3338
New Franklin Air Compressor	3345
Notes	3366
Patents	3370
Philadelphia Filteration System	3355
Vertical Compound Two-Stage Compressor	3350

U.S. PATENTS GRANTED DEC., 1904.

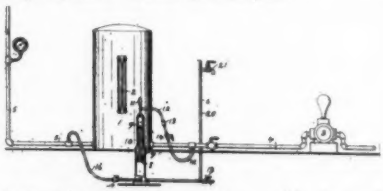
Specially prepared for COMPRESSED AIR.

776,601. AIR LIFT-PUMP. Frederick J. Kuhlmann, Cincinnati, Ohio, assignor to Julia A. Kuhlmann, Cincinnati, Ohio. Filed May 31, 1902. Serial No. 109,644.



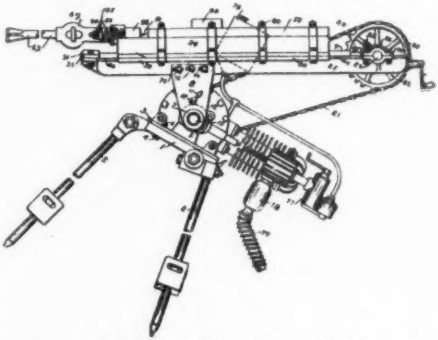
An air lift-pump the combination of an uptake-pipe, and an air-conveyer suspended within the pipe below the water-line and above the inlet-opening of the pipe and which consists of a pipe having an air-discharge near its lower end above the air-discharge an enlarged portion and above the enlarged portion a reduced portion, substantially as shown and described.

776,724. LIQUID-SUPPLY SYSTEM. Xenophon Caverno, Kewanee, Ill., assignor to Kewanee Pneumatic Water Supply Company, Kewanee, Ill., a Corporation of Illinois. Filed May 12, 1904. Serial No. 207,612.



A liquid-supply system, the combination of a fluid-containing tank; means for supplying liquid thereto; an air-pump connected to supply air to the tank, and adapted to be operated by liquid under pressure; and connection for supplying liquid under pressure to the pump from the tank.

776,613. ROCK-DRILLING MACHINE. Leroy S. Pfouts, Canton, Ohio, assignor of one-half to Thomas F. Turner, Canton, Ohio. Filed Feb. 29, 1904. Serial No. 195,945.

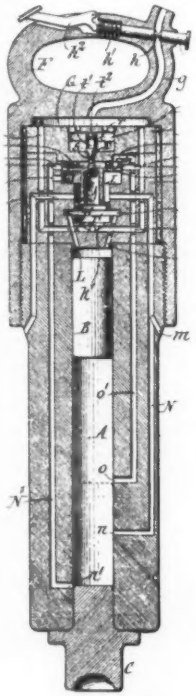


A rock-drilling machine the combination of a support, a turn-table carried by the support, a

motor connected thereto and carried thereby, said support provided with upright members spaced from each other, a drill-frame pivotally connected at right angles to the pivotal connection of the motor turn-table, a sliding carriage and said drill-frame carrying operating mechanism, and the drill-operating mechanism driven from a motor-pion having a common centre with a pivotal connection of the drill-frame and motor-supporting turn-table, substantially as and for the purpose specified.

776,650. PNEUMATIC TIRE. Charles E. Duryea, Reading, Pa. Filed Jan. 16, 1904. Serial No. 189,297.

776,671. PNEUMATIC HAMMER. Max Maximilian, Buffalo, N. Y. Filed Apr. 13, 1904. Serial No. 202,962.



A pneumatic hammer comprising a power-cylinder, a valve-chest having an integral bottom and a separable top and containing a valve-chamber having a large upper cylindrical valve-seat, a small lower cylindrical valve-seat, a lower main air-inlet port opening centrally into the lower end of said chamber, an annular shoulder formed at the lower end of said chamber around said central inlet-port thereof, an intermediate main air-inlet port opening into the small valve-seat above said lower central inlet-port and connected by oblique passages with the upper end of the cylinder, an exhaust-passage opening into the lower valve-seat above said intermediate port, an upper main air-inlet port connecting the upper part of said large valve-seat with the air-supply, another upper main air-inlet port connecting the upper part of said large valve-seat with the lower end of said cylinder and an upper exhaust-port connected with the lower part of said large valve-seat, and an imperforate main distributing-valve arranged in said chamber and having a lower small valve-piston constructed in the form of a downwardly-opening cup and co-operating with said small valve-seat for connecting said main lower air-inlet port either with the main intermediate air-port or with said lower exhaust-port and having the marginal part of its lower end constructed to bear against said annular shoulder, and an upper large valve-piston constructed in the form of an upwardly-opening cup and co-operating with said upper large valve-seat for connecting said main upper air-inlets or said upper and lower exhaust-ports, substantially as set forth.

776,697. PUNCTURE-PLUG FOR PNEUMATIC TIRES. Fred. A. Sieverling, Kansas City, Mo. Filed Apr. 4, 1903. Serial No. 151,124.

776,765. AIR-BRAKE. James J. Turner, Pittsburg, Pa. Filed Nov. 9, 1903. Serial No. 180,451.

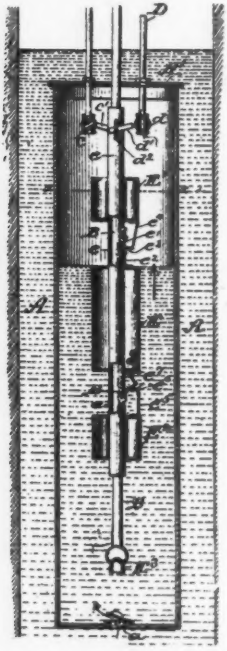
776,883. VACUUM PNEUMATIC SIGNALING APPARATUS. William J. Becker, Milwaukee, Wis. Filed Mar. 24, 1904. Serial No. 199,754.

777,024. PNEUMATIC COTTON ELEVATOR AND DISTRIBUTER. James T. Jackson, Corsicana, Tex. Filed May 9, 1903. Serial No. 156,433.

777,087. PNEUMATIC SANDER. James Farley, Waukesha, Wis. Filed Apr. 15, 1904. Serial No. 203,270.

A sander of the class described, consisting of a casing provided with inlet and outlet openings, a valve supported within said casing in position to close the discharge end of said inlet-opening, lever-arms connected with said valve, an air-cylinder supported alongside said arms, a piston arranged in said cylinder, a stem carried by said piston and extending through the end of said cylinder toward said lever-arms, and means for limiting the travel of said piston.

776,907. PNEUMATIC LIQUID-ELEVATOR. Eddie Hastain, Tishomingo, Ind. Ter. Filed Mar. 12, 1904. Serial No. 197,747.

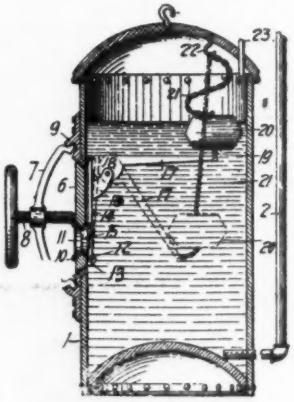


A pneumatic liquid-elevator, comprising a closed chamber having an inlet-valve and a central valved stand-pipe, a compressed-air valve and escape-valve opening into the top of said chamber, a main float surrounding the stand-pipe for operating the said compressed-air and escape valves, means for locking said float against rising and falling, and two supplementary floats also surrounding the stand-pipe and arraged one above and the other below the main float and acting to release the locking devices substantially as described.

777,105. FLUID-PRESSURE BRAKE. Albert Kapteyn, London, England, assignor to The Westinghouse Air Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed Feb. 18, 1903. Serial No. 143,953.

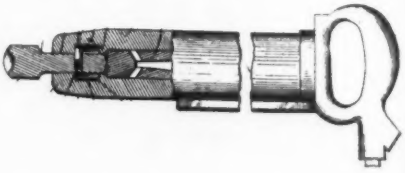
777,340. AIR-BRAKE-OPERATING VALVE. Albert Gottschalk, New York, N. Y. Filed Mar. 24, 1904. Serial No. 199,679.

776,959. COMPRESSED-AIR WATER-ELEVATOR. George H. Stout, Denver, Colo., assignor of one-half to Lucius A. Turner, Denver, Colo. Filed Apr. 7, 1903. Serial No. 151,499.



A water-elevator, a submerged tank having an opening in its vertical wall, a plug adapted to close said tank-opening and having itself an inlet-opening, a valve-plate mounted to swing on said plug and adapted to close its opening, a lever including a cam pivotally mounted on said plug and adapted to close said swing-valve, a float for actuating said lever, means for fastening said plug from the outside, an outlet-opening in the tank and means for discharging the water from the tank.

777,476. LOCKING DEVICE FOR RIVET-SETS. William C. Lippert, Salem, Ohio, assignor of one-third to William A. McGuire, Braddock, Pa. Filed Nov. 11, 1903. Serial No. 180,708.



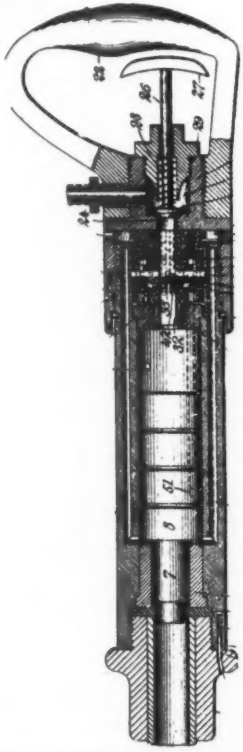
The combination with the grooved cylinder and the tool-shank bearing therein, said shank having a recess formed therein, a locking-pin in said recess, a spring seating in the recess-bottom and bearing against the pin, the cylinder having an aperture therein whereby access may

be gained to said pin to depress the same by use of some instrument or the like capable of entering said cylinder-aperture.

777,201. SAND-BLAST MACHINE. Gottfried R. A. Gutmann, Hamburg, Germany, assignor to The Firm of Alfred Gutmann Actiengesellschaft fur Maschinenbau, Altona-Ottensen, Germany. Filed Aug. 10, 1903. Serial No. 169,035.

A sand-blast apparatus, the combination with a plurality of stationary air and sand-blast pipes each having a hollow shaft mounted in the discharge end and a bent nozzle connected to each shaft of a gear on one of the shafts, a driving-shaft gearing operated by the shaft in mesh with the aforesaid gear, a sprocket on each of said hollow shafts, and a drive-chain connecting said sprockets.

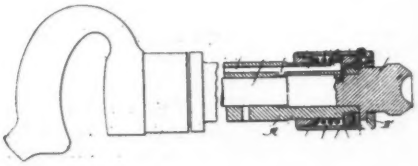
777,368. PNEUMATIC HAMMER. Leonard J. Clossey, Montpelier, Vt. Filed Feb. 20, 1904. Serial No. 194,492.



A pneumatic hammer, a cylinder, a nose-piece removably engaging with the end thereof, automatic means for locking the nose-piece to the cylinder, a bushing in the nose-piece, a collar in the cylinder, and a flexible bushing arranged between the bushing and collar.

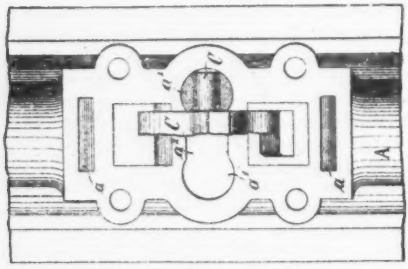
A pneumatic hammer comprising a cylinder, a cap arranged thereon and having an exhaust-chamber, ports leading through the wall of the cylinder certain of said ports communicating with the exhaust-chamber, a sleeve arranged in the cylinder, the said sleeve being closed at about its centre by means of a partition, annular channels on the outer side of said sleeve and having port communication with the interior of the sleeve at opposite sides of the partition, a ring-valve movable on the sleeve and having two interior communicating channels, and an exterior channel having communication with one of the interior channels, and a collar removably engaging with the inner end of the sleeve.

777,681. PNEUMATIC TOOL. John A. Lindstrom, Easton, Pa. Filed Apr. 22, 1904. Serial No. 204,409.



In a pneumatic tool, a cylinder, a piston adapted to reciprocate within said cylinder, a tool, the shank of which fits within the outer end of the cylinder, a cylindrical tool-holder surrounding the outer end of the cylinder, an inwardly-extending annular flange formed at the outer end of the tool-holder, cut-away portions formed in said flange from its inner periphery outward, lugs extending outward from the tool and adapted to pass through the cut-away portions and be turned with the tool so as to lie behind the solid portion of the flange, means for securing the tool against turning when in this position, an enlargement formed upon the outer end of the cylinder, the periphery of said enlargement coming in close contact with the inner wall of the tool-holder cylinder, the rearward end of the tool-holder coming in close contact with the outer surface of the cylinder, a spring coiled about the cylinder and interposed between the enlargement upon the outer end of the cylinder and the rearward end of the tool-holder, an air-supply passage, a port leading from said air-supply passage to the forward end of the piston, and a port leading from said air-supply passage to the space in which the spring is located, as and for the purpose specified.

777,529. VALVE FOR ROCK-DRILLS. Thomas J. Murphy, New York, N. Y. Filed Aug. 15, 1904. Serial No. 220,843.



The combination, with a cylinder portion having two openings whose exterior walls are arc-shaped, said openings being connected by a transverse slot, of two rocker bearing-blocks fitted in said openings and having corresponding arc-shaped exterior faces, said bearing-blocks having trunnion-openings, and a rocker located in the transverse slot and provided with trunnions inserted in the trunnion-openings of the bearing-blocks.

777,718. PUNCTURE-PROOF COVER FOR PNEUMATIC TIRES. John D. Dobelman, Chicago, Ill. Filed Apr. 29, 1904. Serial No. 205,518.

777,719. PNEUMATIC TIRE FOR VEHICLE-WHEELS. George R. Fenner and Frederick W. Trash, London, England. Filed Jan. 25, 1904. Serial No. 190,603.

777,723. PNEUMATIC-DESPATCH-TUBE APPARATUS. Edmond A. Fordyce, Boston, Mass., assignor, by mesne assignments, to Lamson Consolidated Store Service Company, Newark, N. J., a Corporation of New Jersey. Filed Aug. 25, 1904. Serial No. 222,087.

777,897. COTTON-PICKING APPARATUS. Barnwell R. Heyward, Albany, N. Y. Filed Mar. 27, 1903. Serial No. 149,799.

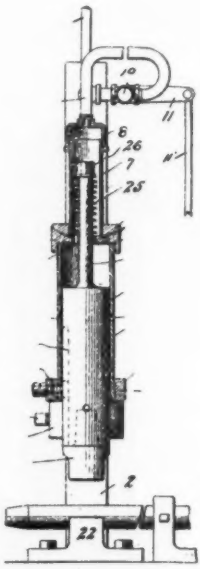
A cotton-harvesting apparatus, a cushioned suction device; a hose in operative connection therewith; a selective tube in operative connection with the hose and means for operating the suction device, all operating to draw the cotton from the boll and through the hose and suction device and prevent damage to the seeds in the cotton substantially as described.

777,979. PNEUMATIC TIRE. Jules F. de Savignac, Marseilles, France. Filed Apr. 6, 1904. Serial No. 201,894.

778,044. FLUID-PRESSURE BRAKE. Artemas A. Kent, Denver, Colo., assignor of one-half to Henry E. Milner, Denver, Colo. Filed June 13, 1902. Serial No. 111,490.

778,116. MOTOR FOR PNEUMATIC FLUE-WELDING MACHINES. Daniel S. Cook, Evansville, Ind., assignor of one-half to Ferdinand Grote, Evansville, Ind. Filed Apr. 18, 1904. Serial No. 203,599.

The combination with a cylinder of a motive-fluid-reception chamber, a piston in the cylinder having a stem in the reception-chamber, exhaust-ports in the cylinder, and means for returning the piston to its normal position.



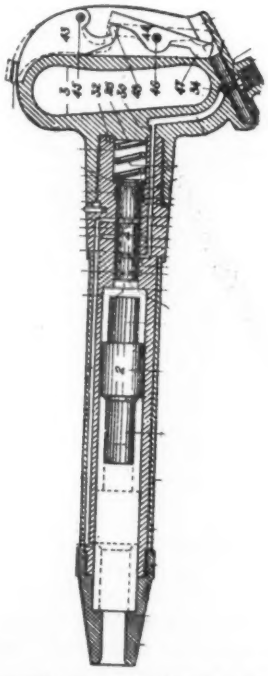
778,136. PNEUMATIC TIRE. Philip Magnus, Northcote, Victoria, Australia. Filed Oct. 5, 1904. Serial No. 227,227.

778,142. DEVICE FOR AUTOMATICALLY APPLYING AIR-BRAKES IN CASE OF EMERGENCY. Charles Parker, Monroeville, Ohio. Filed Oct. 17, 1904. Serial No. 228,829.

778,221. APPARATUS FOR PRODUCING HIGH VACUUMS. William R. Burrows, Newark, N. J., assignor to General Electric Company, a Corporation of New York. Filed Apr. 8, 1901. Serial No. 54,861.

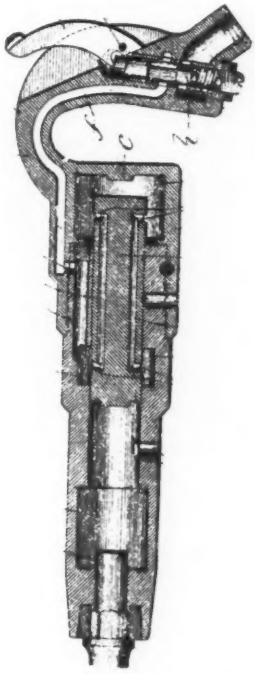
Means for producing high vacua, comprising a group of vessels to be exhausted and two pumps either of which may be connected to the whole group, means by which disconnecting one pump from the vessels connects the other to them, and means for separately cutting off the pump connection of each individual vessel close to the vessel itself.

778,310. PNEUMATIC TOOL. Richard W. Funk, New York, N. Y., assignor to Hudson Machine and Pneumatic Tool Co., Jersey City, N. J., a Corporation of New Jersey. Filed Apr. 10, 1902. Renewed May 18, 1904. Serial No. 208,560.



An improved tool of the class described, comprising a barrel, a hammer slidably mounted therein, a spring-cushioned tubular valve slidably mounted in said barrel inwardly of said hammer, exhaust-ports in said barrel alternately opened and closed by said valve, air-passages controlled by said valve and whereby air is alternately introduced in front of and behind said hammer, and means controlled by said hammer for intermittently introducing air behind said valve; said valve being open at its outer end and provided with a closed inner end the outer surface area of which is larger than the inner surface area of the same.

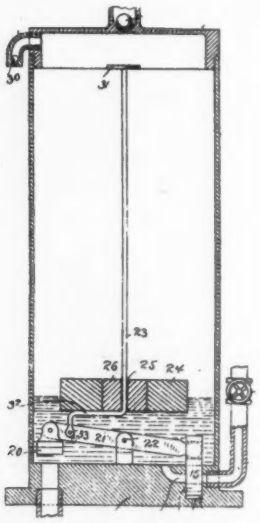
778,319. PNEUMATIC TOOL. Herman Leineweber, South Chicago, Ill., assignor of one-half to William F. Behrens, Chicago, Ill. Filed Mar 19, 1904. Serial No. 199,023.



A pneumatic tool having a casing carrying at one end the tool and at its opposite end a handle, the combination with the casing of a valve-controlled air-pressure-supply passage, end chambers and an intermediate feeding-chamber for the air-pressure in the casing, said feeding-chamber communicating with said passage, a piston reciprocably confined in the casing, hav-

ing, one or more ducts each terminating at its ends in lateral openings in the piston, whereby at the end of each piston-stroke the opening or openings register with said feeding-chamber, and exhaust-ports in the casing for said end chambers.

778,608. AUTOMATIC AIR-COMPRESSOR. John Rogers, Bridgeport, Conn. Filed Dec. 23, 1903. Serial No. 186,311.



An air-compressor comprising a cylinder having induction and eduction pipes and valves in said pipes, a pivoted lever to whose opposite ends said valves are connected so that they will open and close alternately, an outgoing air-pipe provided with a valve, an air-inlet pipe provided with a valve, a rod extending upward from the lever and offset near its lower end and having a free upper end provided with a head and a float moving freely on said rod, the float rising on the rod as water rises in the cylinder and by engagement with the head raising the rod, tilting the lever and simultaneously opening the eduction-valve and closing the induction-valve, and said float falling with the water and closing the eduction-valve and again opening the induction-valve, said action being continuous so long as the water-supply continues.

778,495. PNEUMATIC TIRE OR OTHER FLEXIBLE TUBULAR ARTICLE. Arthur H. Marks, Akron, Ohio. Filed May 3, 1904. Serial No. 206,146.

778,496. PNEUMATIC TIRE OR OTHER FLEXIBLE TUBULAR ARTICLE. Arthur H. Marks, Akron, Ohio. Filed May 3, 1904. Serial No. 206,147.

778,497. PNEUMATIC TIRE OR OTHER TUBULAR FLEXIBLE ARTICLE. Arthur H. Marks, Akron, Ohio. Filed Mar. 31, 1904. Renewed Nov. 10, 1904. Serial No. 232,132.

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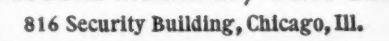

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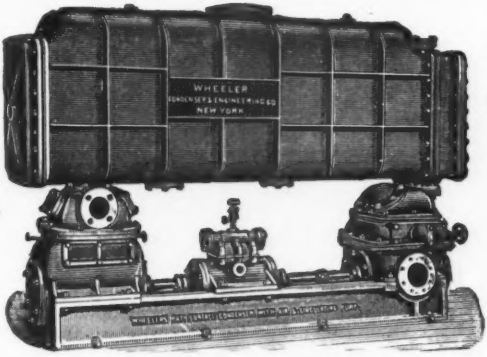

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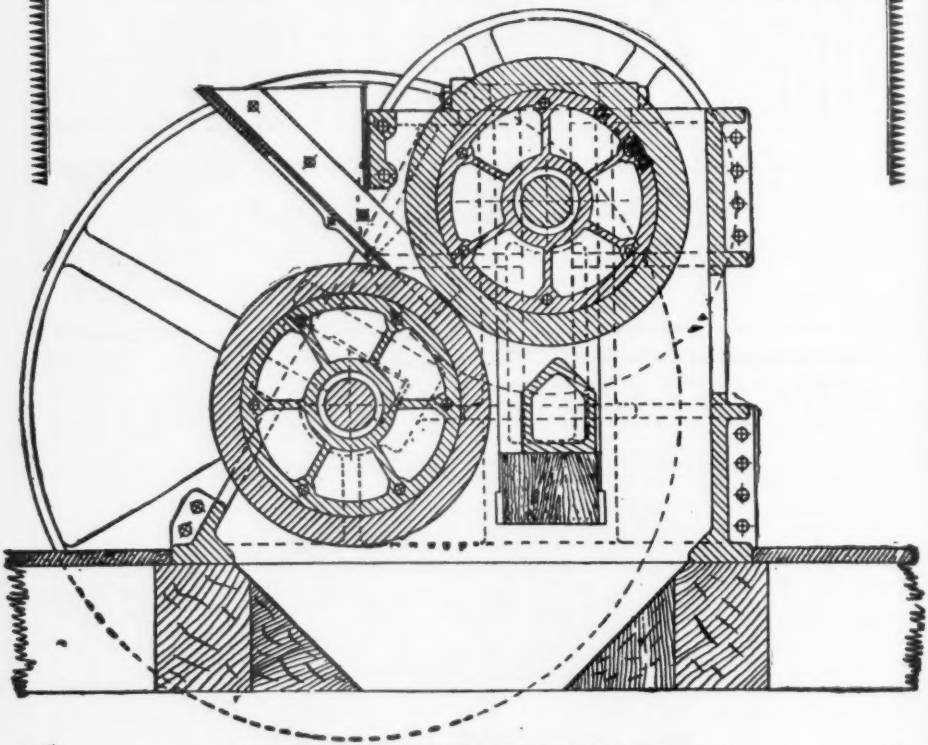

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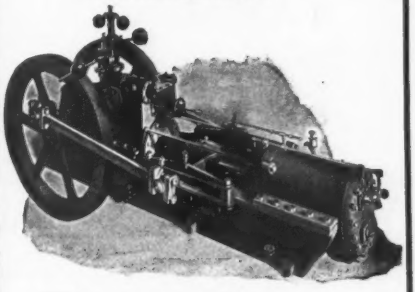

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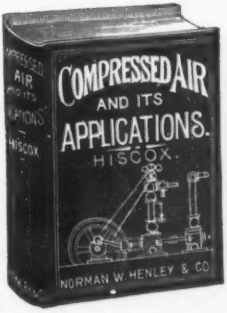

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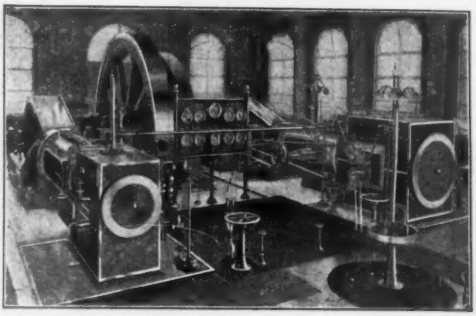

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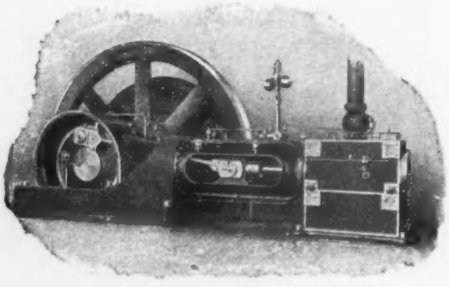

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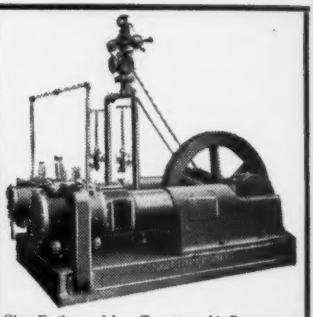

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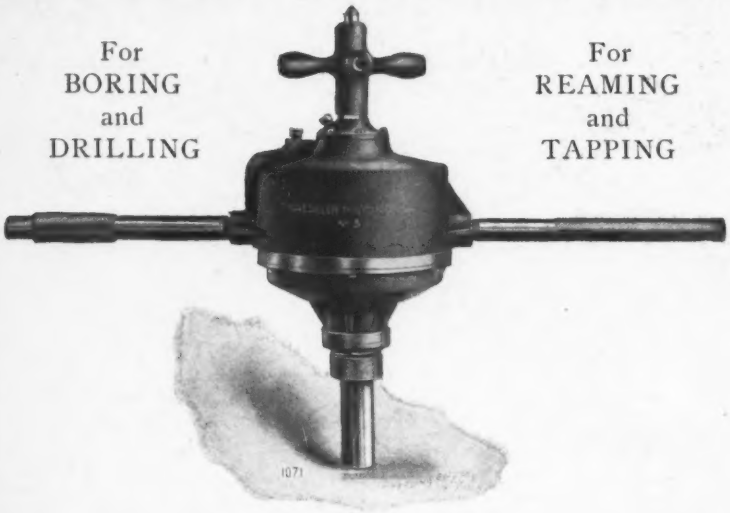

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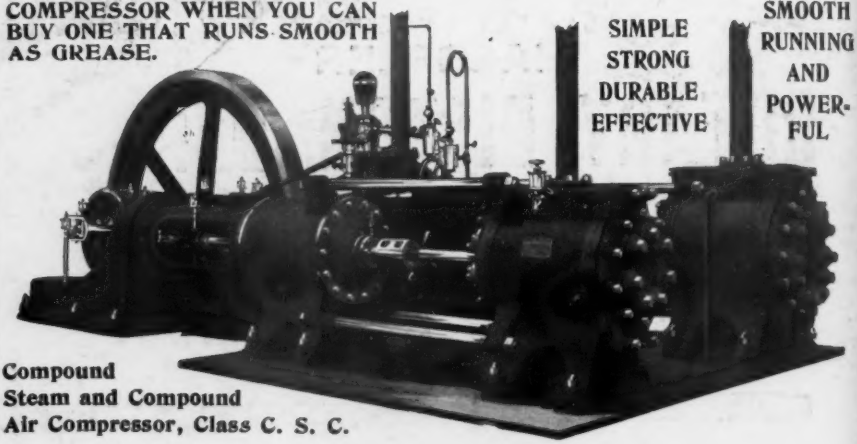

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